Hang Gliding

THE PUBLICATION OF THE UNITED STATES HANG GLIDING ASSOCIATION

Special New Pilot Issue!

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HANG GLIDING magazine is published for hang gliding sport enthusiasts to create further interest in the sport, by a means of open communication and to advance hang gliding methods and safety. Contributions are welcome. Anyone is invited to contribute articles, photos, and illustrations concerning hang gliding activities. If the material is to be returned, a stamped, self-addressed return envelope must be enclosed. Notification must be made of submission to other hang gliding publications. **HANG GLIDING** magazine reserves the right to edit contributions where necessary. The Association and publication do not assume responsibility for the material or opinions of contributors. **HANG GLIDING** editorial offices: 6950 Aragon Circle, Suite 6, Buena Park, CA 90620 (714) 994-3050.

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VIEWPOINT

Hang Gliding: Isn't That Dangerous?

by Mike Meier

"Boy that looks like fun! But isn't it awfully dangerous?"

These are the sentiments that confront most hang glider pilots when approached by a spectator at the local flying site. Most everyone who sees it agrees that hang gliding looks like a lot of fun (it is!). And most everyone unfamiliar with hang gliding seems convinced that it must be very dangerous. (And they're right, sort of.)

Like other forms of aviation, there is a certain inherent danger in hang gliding; you're up above the ground, and if you fall you have a good chance of hitting hard enough to get hurt or killed. On a statistical basis, hang gliding ranks comparably with other high-risk sports. Among experienced pilots, we lose about one pilot per 1,000 participants per year (students under instructor supervision are statistically much safer).

But statistics are not really the point. The important safety question for a new or prospective hang glider pilot is, How safe is hang gliding going to be for you? Fortunately, the answer to that is largely up to you.

We know what kinds of things cause fatal accidents, and what pilots can do to avoid them. In hang gliding, unlike most other forms of aviation, you need not depend on the skills or judgement of anyone else for your safety. No air traffic controller is going to vector you and someone else to the same point inside a cloud at the same time. Your safety is yours to control, and at the same time, it is entirely your responsibility. Most hang gliding accidents involve errors in pilot decision making that are both gross and easily identifiable. This article is about personal strategies you can use to make your flying safer. They won't make your flying completely risk free—very few activities are—and they won't make it any less risky than you decide you want it to be, but they will give you a very high degree of control over your own level of safety.

What is required to survive a career in aviation is not any particular level of flying skill, or experience, or knowledge. Highly skilled, experienced and knowledgeable pilots kill themselves as often or more often than do pilots with less of all these attributes. Three things are required to be a safe pilot: the desire to be a safe pilot, an understanding of where safety in aviation comes from, and the maturity and self-discipline to act on your knowledge and desire.

It is interesting to look at the history of accidents in hang gliding for clues to the important factors that determine safety. Hang gliding had a very poor statistical safety record in the early 1970's. Today this is often attributed to the inferior design and airworthiness of the early generations of hang gliders. Today's gliders, it is said, are vastly superior in design; stronger, more stable, and this has made the sport safer. If we look critically at this argument, however, we see a slightly different picture.

Hang gliders in the early 1970's were very simple, and limited in performance, strength and stability. The basic skills of hang gliding were very easy to learn. The average hang glider pilot was in his early to mid 20's, was unmarried, and had one year or less of flying experience, usually limited to hang gliders. He was probably self-taught, or learned from a friend. His view of hang gliding was probably somewhat cavalier; many at that time preferred the term "Sky Surfing," as though hang gliding were not really an act of aviation, but rather a simple three-dimensional form of fun at the beach.

As the sport has evolved, the gliders have become higher performing, stronger and more stable, but also more complicated, more expensive, and a lot harder to learn to fly. Today the average hang glider pilot is in his mid to late 30's. He is married, probably with children. He has a substantial income (he needs it at today's hang glider prices). He has five to ten years of flying experience, including hundreds of hours, and his flying experience may even extend beyond hang gliders to sailplanes or airplanes. If he is new to the sport since the early 1970's, he probably learned to fly from a professional instructor in a fairly comprehensive training program, and he had to have a significant amount of personal dedication to stick with it through the learning process. (If he is a veteran of the early 70's, then he is one of the pilots who sur-

vived that period, and by the process of natural selection he is an inherently safer pilot.)

If you compare the average pilot who entered the sport in 1974 to the average pilot today, it is obvious that the latter group could not help but be a statistically safer pilot population. The moral of the story is this: Pilot safety is a matter of individual pilot attitude. The nature of modern hang gliding and modern hang gliding equipment has selected in favor of a population of pilots who are better trained, more mature, and take their flying more seriously. The specific type of attitude required for safe flying is one that a person tends to acquire with age and maturity.

To be a safe pilot, you must be capable of the following:

First, be able to recognize the limitations of your equipment, and of your personal skills and knowledge.

Second, have the self-discipline to consistently operate within those limitations.

Third, pay attention to all the little details of preflight procedure and equipment maintenance.

Safety will often involve as simple an act as just deciding not to fly, because on that day the conditions or the site are just not comfortably within your capabilities or those of your equipment. Maybe it's a new site and the launch is just a little too precipitous, and a little less forgiving than you feel comfortable with. Maybe you're unsure of the weather; the wind speed seems okay now, but it's marginally high and a little on the gusty side, and that cold front to the northwest on the weather map in the morning paper has you thinking that maybe conditions are going to build to an unsafe level after you're in the air.

Sometimes staying on the ground can be the hardest thing to do. As a beginning to intermediate level hang glider pilot, you know you should avoid flying in strong thermal conditions. And when friends of yours, with no more skill or experience than you have, are out there gaining thousands of feet of altitude in middle-of-the-day thermals, it may be hard for you to stay on the ground and wait for the smoother, weaker lift at the end of the day. It will be especially hard when you notice that they seem to be getting away with it, and when you think about listening to their "there I was" stories that evening in the landing area. But if you really want to be a safe pilot, this is the kind of hard decision you have to be able to make. Look at it this way: during the next ten years you'll probably have at least 10,000 significant decisions to make as a pilot. (Do I fly today? Do I have enough room to turn back toward the hill in this thermal? In this one? Can I follow this thermal back and still have enough glide to get back over the ridge top and avoid the rotor?) If you make the "go" decision whenever you think you have a 90% chance of making it through alright,

The USHGA Safe Pilot Award

In August of 1988, the USHGA established an award program to recognize safe pilots—the USHGA Safe Pilot Award. The basics of the program are this: pilots earn awards at increasing levels, based on logging a consecutive string of safe flights. The levels are as follows:

Bronze Award	100 consecutive safe flights
Silver Award	300 consecutive safe flights
Gold Award	500 consecutive safe flights
First Diamond	1,000 consecutive safe flights
Second Diamond	2,000 consecutive safe flights
Third Diamond	3,000 consecutive safe flights
Fourth Diamond	4,000 consecutive safe flights
Fifth Diamond	5,000 consecutive safe flights

The flight requirements are total for each award level; in other words, it takes 200 consecutive safe flights after a bronze award to get a silver award. The consecutive requirement, however, is key: a pilot with 950 consecutive safe flights, who then has an unsafe flight, now needs a full 1,000 consecutive safe flights after the unsafe flight to earn his First Diamond award. (He does not earn a second award at the bronze, silver and gold levels along the way, he merely "revalidates" the awards already earned at those levels.) Therefore, as your string of safe flights grows longer, you have more and more incentive to make sure you don't make a mistake. The program has been designed to make it especially accessible to new pilots; since the levels are based on number of flights, new pilots can often earn awards in a shorter period of time than more advanced pilots.

A safe flight consists of a takeoff and landing, starting from rest and ending in a complete arrest of forward motion, in which no injury occurs to the pilot which requires or would cause a prudent person to seek medical attention from a licensed medical practitioner. (There has been some controversy over this definition of a "safe flight," and the program contains a qualifying clause which essentially encourages both the applicants and the approving directors to define as unsafe any flight in which injury was avoided only through the intervention of fortuitous circumstances. I believe it will often be true that a greater contribution will be made to the cause of safety by the consideration and discussion of whether a particular flight was safe or not, than by the final determination in answer to that question.)

The documentation required for the award is minimal and fairly simple. The pilot must log each flight, with a minimum of the date, location and duration of the flight. The pilot must obtain an application form, either from the USHGA office or a local shop, instructor or director, and fill out the form attesting to his string of consecutive safe flights. The pilot must get three USHGA members to sign the application attesting to having known the pilot for the period of time during which the claimed flights took place, and attesting to the pilot's lack of injury during that time. And finally, the pilot must submit the application, with his logbook, to a USHGA regional, at-large, or honorary director, for final approval. Pilots earning the award receive a pin and a certificate from the office, and have their names published in *Hang Gliding* magazine.

To date, more than 100 safe pilot awards have been earned, including more than 20 Silver awards, and seven Gold awards. Three pilots—Rob McKenzie, Paul Voight and G.W. Meadows—have earned the diamond award, and Rob McKenzie has earned his third diamond.

Fly safely, and log your safe flights. ■

VIEWPOINT

you won't make it 1,000 times. If you raise your threshold to 99%, you still won't make it 100 times. If you raise it to 99.9%, you'll still be in serious trouble 10 different times. Your go/ no-go decision has to be 100% certain. Nothing else is enough.

This doesn't mean that you will never try new things. All pilots must "stretch the envelope" of their own skill and experience limitations in order to progress. But you can pick your spots; give yourself an extra margin for error when you venture into unfamiliar territory.

In addition, to be safe, a pilot has to take his flying and his safety seriously enough to pay attention to the more mundane aspects of safety—such as proper equipment maintenance, pre-flight checks, and so forth. Just about every year at least one pilot kills himself by simply neglecting to attach himself to his glider before flinging himself off a mountainside. If you can avoid stupid mistakes, and if you can consistently make the tough, conservative decisions in your flying that keep you on the safe side of your limitations, you can have a safe aviation career.

If you've been inside a pilot shop or flight school office, you've probably seen the poster that says:

"Aviation is not inherently dangerous, but it is extremely unforgiving of any carelessness, incapacity or neglect."

It's a favorite among pilots. It's a comforting sentiment, because it implies that what we do as pilots isn't really dangerous after all. It's one of those things that is so cleverly written and sounds so good that it ought to be true. But it isn't. Aviation *is* inherently dangerous. It's one of the most dangerous things you can do. It is sometimes forgiving. (Anyone who's been around flying for very long can tell you stories of pilots who suffered spectacular crashes and walked away from them.) But aviation does not forgive often enough, and it does not forgive with any sense of fairness. Pilots sometimes survive the grossest errors in judgement, while other times what seems like a simple mistake leads to a fatality.

You can have a safe career in aviation. We have outlined what is required, and the decision to choose safety is up to you.

And if you insist on a clever quotation about safety in aviation, try this one:

"Aviation has made the world a lot smaller, but it is still pretty hard to miss it if you fall."

Fly safely. See you in the sky. ■

The following statistics were published in the April 1992 issue of Hang Gliding. *Of the nine fatalities in 1991, on which the following is based, there were two pilots who failed to hook into their gliders, one who forgot to put his legs through the leg straps of his harness, one who fell from a cliff after landing and unhooking from his glider, and one who was killed doing aerobatics 200 feet above the ground. The conclusion is: if pilots had avoided these kinds of mistakes our fatality rate would have been half that shown below.—Ed.*

ACTIVITY	Fatalities/100,000
Timber faller/logger	129
Airline pilot	97
Power line installer/repair	50
Fireman	49
Peace Corps	42
Garbage collector	40
Truck driver	40
Roofer	32
Flight attendant	23
Real estate agent	7
Editors and reporters	4
Driving a car	28
15-25 year-old male driving	50
Motorcycle rider	80
Motorcycle in Arkansas	250
All terrain vehicle	36
Airshow	500
Home-built aircraft	300
General aviation	145
Ballooning	67
Sailplane soaring	45
Skydiving	25
Hang gliding	22

number of deaths
4 5 6 7 8 9 10 11 12
fatality rate per 100,000
10 12 15 17 20 22 25 27 30

For further details see *Hang Gliding* magazine, Dec. '89, pages 7-8.

INDEX TO ADVERTISERS

Buying A

© by G.W. Meadows

You've been on the hill for a few days now and this hang gliding stuff is starting to look like something that could turn into a hobby. You're definitely going to have to give it some serious thought. One of the most important things folks have to consider is the cost, and how it can be kept to a minimum.

I've been hang gliding for a long time, have taught quite a few people this wonderful sport, and have helped some of them save money in the right places. The purpose of this article is to help you make a wise decision when trying to be frugal.

One of the last things you want to be cheap about is your glider. To be honest, if you can't afford a good glider, one way or another, you should probably postpone your decision to enter the sport. Whenever possible, purchase the glider your instructor recommends. He has been at this for a while, and understands why a certain glider will be best suited for you. I personally recommend a new glider in your class and weight range. There are a number of new gliders on the market these days that are incredibly well suited for the beginner pilot's first purchase. Those of us who have been around for a while would have loved to have the opportunity to do our early flying in such nimble and forgiving aircraft. The modern-day pilot who is just starting out in the sport should consider himself fortunate.

Although I would love to see *all* new pilots in new, state-of-the-art, entry-level gliders, the reality is that there are some really excited folks out there who would just love to get into this sport, but just can't afford a new wing. So if you're going to buy a used glider, at least let me steer you in the right direction.

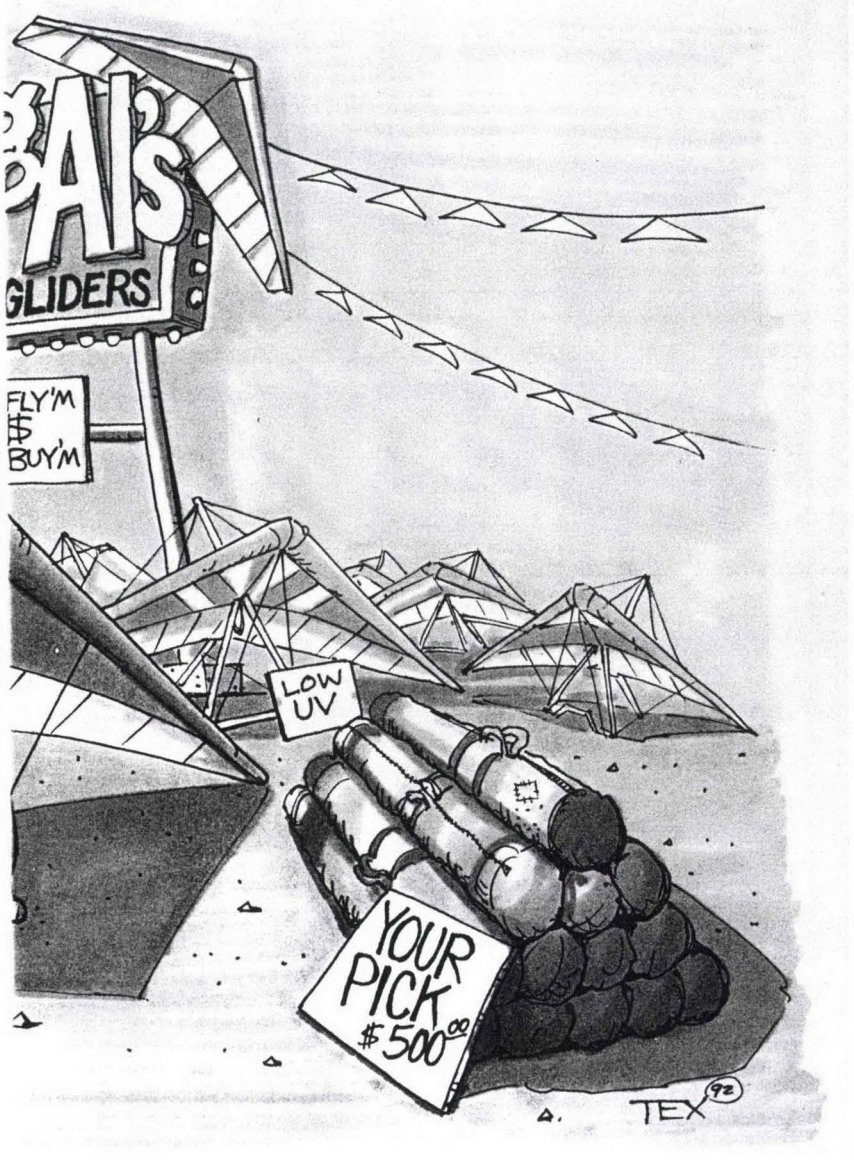
If I were talking to you in person I would name the used gliders I think are well suited for you at this stage. Unfortunately that isn't the case, and since I don't know you or your aspirations in hang gliding I'm going to give some guidelines to go by.

DON'T purchase a glider that was made before 1979. Period! The money you'll save won't justify the hassle and possible danger you may subject yourself to.

Just because I ruled out all gliders made before 1979 doesn't mean I'm recommending all gliders made after that. Quite the opposite. There are some gliders made since 1979 that I wouldn't wish on anyone. The hard part is judging which ones are good and which ones are bad. To begin with, if a glider was considered high performance in its day, that meant it was also hard to fly. If it was hard to fly then, it's hard to fly now. The gliders that fall into this category will be extremely cheap ($300 to $500) and should be avoided. Most gliders that were good beginner gliders when they were built are still good beginner gliders now. The absolute best thing you can do when considering a used glider is to call up a reputable instructor

sed Glider

illustration by Bill "Tex" Forrest



and ask what he thinks about that particular model. If the instructor doesn't give you the answers you're looking for, call another. If two instructors agree that a glider model isn't for you, listen to their advice. As a basic rule of thumb you should plan on spending an absolute minimum of $700 for a reasonably good used beginning glider, but $1,000 to $1,500 is more realistic when it comes to a quality used wing. Again, buy new if possible.

DON'T buy a glider with lots of rust on the hardware. If the glider you're looking at has rusted bolts it's not been taken care of very well. You should do a thorough inspection of the glider and its hardware. If you find rust on any of the bolts and/or other hardware you should also thoroughly inspect the aluminum tubes for corrosion (inside and out). Corrosion on aluminum has a different look than corrosion on steel. On aluminum, corrosion will look like a white powder that is adhered to the corroded part. Usually this will be found on the inside of aluminum tubes and under sleeves. Look very closely at the end of all sleeves and around bushings and rivets. If you discover any significant amount of corrosion, move on to the next glider.

DON'T buy a glider with dented or bent frame parts unless there is a professional willing and able to fix the glider with the appropriate parts. It is nearly impossible to find parts for many gliders on the used market. If a leading edge or crossbar is damaged it may be necessary to remove the opposite, undamaged part and duplicate it with raw materials. This is extremely labor intensive, and by the time your "new" glider is ready to fly you may have more money in it than you had planned on. The answer to this problem is to stick with a late model made by a manufacturer that is currently in business.

DON'T buy or fly a glider that has kinked wires. Many used gliders will have wires that need replacing. Even gliders that are a year or two old may need new wires. If a side wire has a serious kink (45 degrees or more), it needs replacing. Tensioning and relaxing a kinked wire repeatedly will eventually lead to failure of at least some of the strands. Kinks next to or between nicos at the wire ends warrant special attention. Damage to a wire where it enters a nico is much more difficult to detect than damage along the span of the wire. In addition, look for wire and nico fitting corrosion, which will probably require replacement of the wire. Many gliders will have heat shrink tubing over the nico fittings. After a few flying seasons, visual inspection of this area becomes more difficult as a result of discoloration of the heat shrink. If you cannot visually inspect this area you should carefully remove the heat shrink.

DON'T purchase a glider with a UV (ultraviolet) degraded sail. A good way to check for this

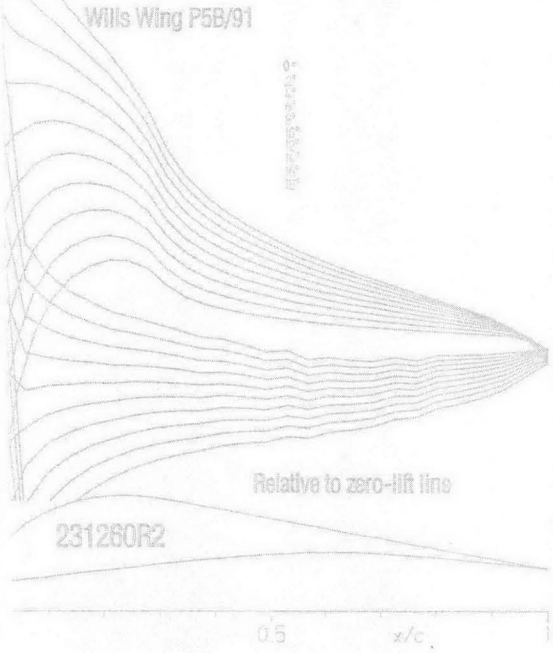
problem is to try to force your thumb or an eraser on the end of a pencil through the sail. This test should only be performed in the presence and with the approval of the owner. If you feel the sailcloth giving, or if you actually poke a hole through it, this will not be a wise purchase. (NOTE: Although color fade is a good indication of the amount of UV exposure, many gliders produced in the last four or five years have fluorescent-colored leading edge pockets. This material is widely known to fade prematurely because of the pigmentation. When considering one of these gliders you will not necessarily want to use the faded color of these leading edges as the sole judge of UV exposure.)

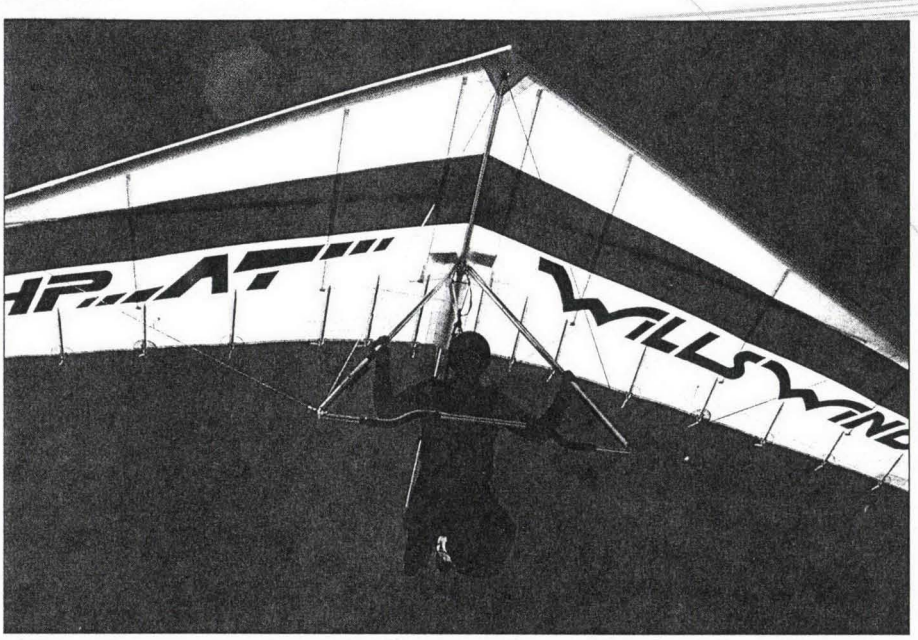
DON'T buy a glider for which you will not be able to obtain a batten pattern. One of the most critical considerations when it comes to glider stability and performance is maintenance of the airfoil. This point is more important than most people realize.

"DON'T buy a glider before you fly it. You might think this would go without saying, but I often encounter people who bought a used glider without actually trying it out. Just because you've seen the glider fly doesn't mean it's going to fly the way you expect it to."

DON'T buy a glider before you fly it. You might think this would go without saying, but I often encounter people who bought a used glider without actually trying it out. Just because you've seen the glider fly doesn't mean it's going to fly the way you expect it to. This doesn't apply as much to a new glider, because it will have been pre-tuned and test flown twice before the customer receives it. This ensures that the glider being purchased will fly as close as possible to the one the customer test flew. You'll also do yourself a favor by test flying the glider you're considering in the kind of conditions you are familiar with, even if that means going to the training hill. Flying in nasty air is no way to get a good feel for the handling characteristics of a glider.

Well gang, there are some guidelines to go by when looking at used gliders. Again, I recommend a new glider if you can afford it. As with all things I give advice on, if you have a dealer or instructor you trust, go with his recommendation. This article is not meant to override your instructor's suggestions. ■





e Company: Founded in 1973 on mple idea: *Build the highest quality ipment for personal soaring flight, and k those products with an unmatched el of customer service.* Wills Wing has vided continuous service to the hang ng community for nineteen years.

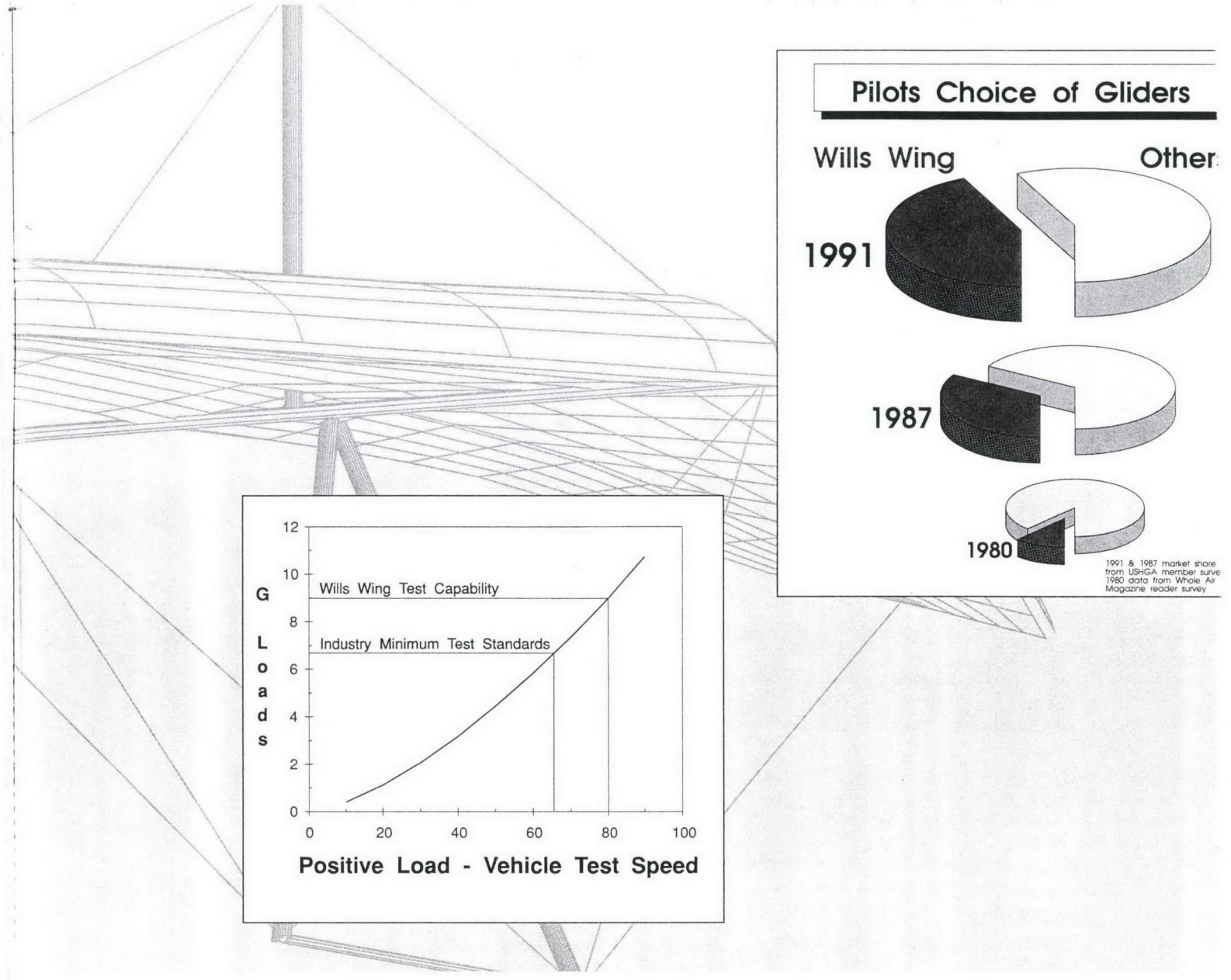
e People: At Wills Wing we love g. All four of Wills Wing's corporate ers are active pilots, and we fly ything from paragliders and hang ers to sailplanes and multi-engine anes. Our production personnel and pilots are the most highly trained and t experienced in the industry.

e Means: Product design at Wills g is a synthesis of basic engineering amentals, advanced computer ysis, and nearly two decades of tical experience. Product development ves extensive and painstaking vehicle and flight testing, to insure that our own personal standards for flight characteristics, performance and safety are met.

The Products: Wills Wing offers the most complete and highest quality product line in the industry. All Wills Wing glider models are HGMA certified before the first customer unit is delivered, and every Wills Wing glider is factory and dealer test flown prior to being personally delivered by the dealer to the customer.

▼**HP AT** - In 1984, Wills Wing pioneered a revolutionary new configuration in competition class hang gliders with the introduction of the first of the HP series of gliders. By early 1990, continued innovation had given rise to the HP AT 158 and HP AT 145, the most highly refined and most often imitated competition class gliders on the market. In 1991 HP AT pilots won 10 major domestic and international championships. Through the '91 season, HP pilots had logged 20 cross country flights of over 200 miles, nearly twice as many as all other glider models combined. In 1990, Larry Tudor flying an HP AT 158, picked up two FAI world records by recording the first ever three hundred mile flight in a hang glider. In 1991, Jim Lee set the world triangle distance record on an HP AT 158, and Kari Castle, on an HP AT 145, made the first flight over 200 miles by a woman pilot, setting a world record in the process. Through 1991, fifteen out of the last twenty U.S. World Team pilots had selected Wills Wing gliders as their glider of choice for world championship competition.

▼**Spectrum** - In 1990, with the introduction of the Spectrum, Wills Wing changed the nature of entry level hang gliding. For the first time, the new pilot was given access to true high performance, along with the type of advanced technology normally



associated with top of the line competition class gliders. Available in two sizes for pilots from 110 lbs. to 240 lbs., the Wills Wing Spectrum offers the advancing novice and casual recreational pilot an unmatched value in quality, performance, and soaring enjoyment.

▼**Super Sport** - Brand new in 1991, the performance and flight characteristics of the Super Sport lie directly between those of the Spectrum and the HP AT. Designed for the intermediate and advanced soaring and cross country pilot, the Super Sport features technology derived from the HP AT, including the HP AT airfoil, airframe technology, and general sail planform. At the same time, the Super Sport's handling qualities and landing characteristics are more reminiscent of those of the Spectrum, yielding a glider of extraordinarily accessible soaring and cross country performance.

The Result: A true dedication to quality in products and services results in a high level of customer loyalty and support. In every year since 1984, more U.S. pilots have chosen Wills Wing gliders than any other, and the percentage continues to grow year by year. In 1991, more pilots owned Willls Wing gliders than the next three most popular brands combined, and ninety-six per cent of the pilots who purchased new Wills Wing gliders rated the service they received from Wills Wing to be good to excellent. As a member of the international family of Wills Wing pilots, you can enjoy the benefits of Wills Wing quality service from more than 200 professional dealers in 35 countries all over the world.

The Future: We're working every day to provide all of our customers with better products and better services. If you're already a Wills Wing pilot, we'd like to thank you for your support, and ask you to let us know how we can serve you better. If you've never owned a Wills Wing glider, we cordially invite you to talk to your Wills Wing dealer, and take a demo flight on a new Spectrum, Super Sport or HP AT. We're looking forward to building your next glider.

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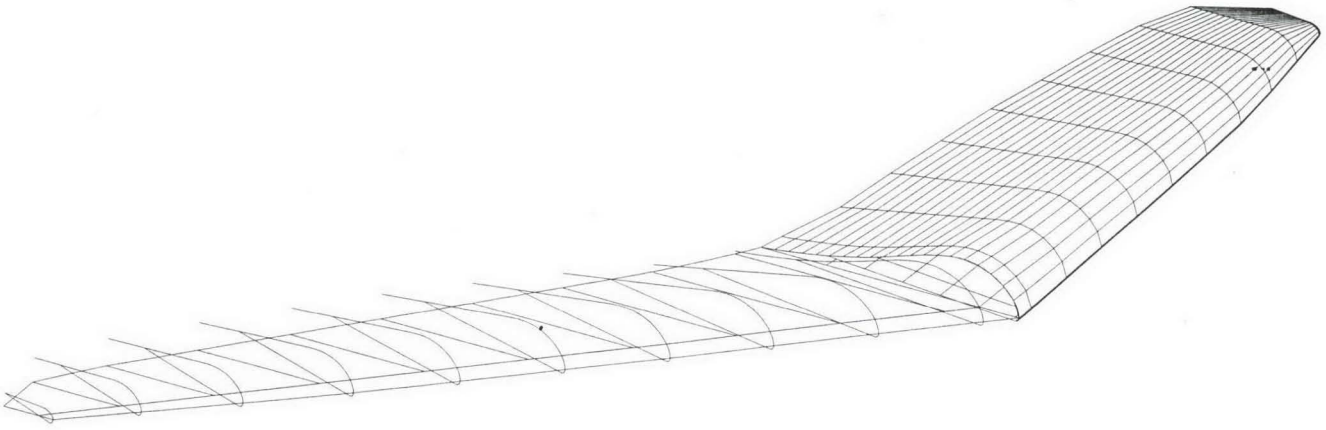


SAIL PATTERNS ARE GENERATED FROM A 3-D MODEL OF THE DESIRED PLANFORM AND GEOMETRY BY UNFOLDING THE DEVELOPED SURFACE AND CORRECTING FOR FABRIC STRETCH BEHAVIOR

The Design Of A Modern Hang Glider

by Mike Meier and Steve Pearson

Introduction

This article describes how a new hang glider model is conceived, designed and developed. Most of the steps described are involved in the design of any hang glider, though there may be wide variation in how they are carried out, depending on the resources available.

Airfoil design can vary anywhere from a sophisticated computer analysis of pressure and velocity distributions over the range of expected angles of attack, to the most basic TLAR method (That Looks About Right). The structural evaluation of hardware might include a finite element analysis of anticipated stress distributions, or be as simple as bolting the prototype part to a bench and whacking it with a large hammer to simulate impact loads on a hard landing. Neither of these approaches is necessarily superior to the other, and, in fact, the most successful design teams have traditionally taken full advantage of both the abstract analytical approach and the intuitive, "get the hammer" approach. Ultimately, the success of any design will depend on the total level of effort and talent that are brought to bear on every aspect of the process—from original conception, to design, to developmental testing and modification, to production and quality control. Although innovative ideas and technical analysis can be very important in the initial design phase of a new glider, in the long run it is the ability of the designers to combine their experience, intuition and practical skills in a comprehensive and thorough program of design, evaluation, testing and redesign that will determine the ultimate level of success of the project.

Pioneer hang glider designer and aeronautical engineer Tom Price used to tell an illustrative story from his days working at Douglas Aircraft. It seems that a team of junior design

STABILITY

Stable throughout range of motion. Ball always tends to move towards center.

Unstable at any position in range. Ball always moves away from center.

Stable in one range of motion, unstable in another.

Imagine the stable range as the normal range of speeds (angles of attack) at which a glider is flown, and the unstable range as those very low angles of attack corresponding to speeds above the normal flight realm, and you will understand the value of vehicle pitch stability testing. The unstable range might never be used during normal flight, and the instability might not be apparent to the designer or pilot, but in turbulence or abnormal maneuvers this unstable range might be encountered with disastrous results.

engineers had been given the assignment of coming up with a new spar design for a wing. They brought the full weight of their engineering degrees and computer capabilities to bear on the project, and eventually emerged with both a design and reams of computer calculations on structure and fatigue to back it up. They brought all of this material to their boss, a senior designer with years of design experience. He looked briefly at the design, and saw immediately that it was wrong. Disdaining the pages of computer calculations, he brought out his slide rule and in a few minutes found the errors in their work.

Step One — Marketing

The first step in designing a glider is to decide what market the glider is intended to serve. Who is the pilot who is going to buy and fly this glider? What is his skill level? How much money does he want to spend? What are the most important qualities to him—performance, superior quality and finish, ease of launching, flying and landing, light weight, minimum cost...? Then, what is your competition in that market; what other gliders currently serve that market and what will you do to make yours more attractive.

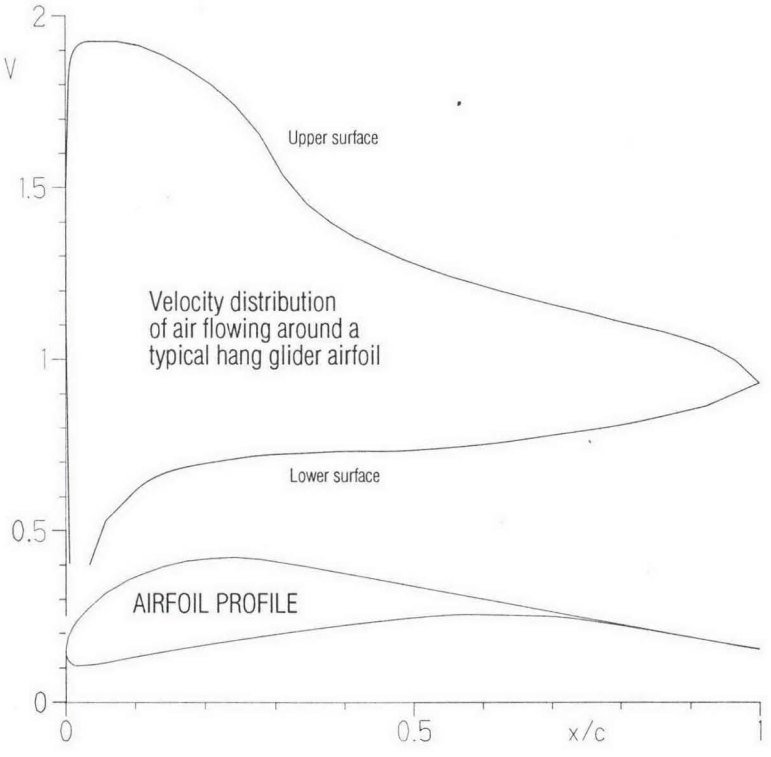
Step Two — General Design, First Try

After deciding on the target market, the next step is to rough out the glider configuration. This step consists of choosing among a series of compromises to try to maximize the appeal of the product for the targeted market. These decisions will affect every aspect of the glider: the performance, the ease of ground handling, launching, flying and landing, and the cost. Specific attributes of the glider such as the glide ratio and sink rate performance, speed range, glider weight, static balance, control bar size, levels of pitch, roll and yaw stability and damping, pitch and roll control pressures and authority, and landing flare authority will all be affected by the decisions made with regard to general configuration.

Planform: A planform (general outline shape of the wing) must be chosen, which includes the span and area of the wing, the amount of sweep and taper in the wing, the percentage of double surface, and the number (and therefore density) of the sail-shaping battens. More span means higher performance, but reduced turning control authority and increased turning control effort. Increased sweep means greater yaw stability, which means that the glider will more automatically tend to point its nose in the correct direction when maneuvering. However, at the same time, increased sweep hurts performance, both directly and by requiring higher levels of twist to avoid making the stall and spin characteristics less forgiving.

Airframe and Hardware: A structural configuration must be chosen, including the materials used, the size and configuration of the airframe spars, the level of anhedral (downward fold of the wings about the keel axis) or dihedral (upward fold) in the airframe, the set-up procedure and the required hardware fittings. In materials, a higher strength alloy can provide a lighter glider of the same strength, or a stronger glider of the same weight, but only at a higher cost. The spars will normally be made of seamless, drawn, round tubing. The sizing, lengths, and sleeve lengths and locations of the spars will affect both the strength and distribution of flexibility in the airframe, which must be matched to the desired performance and handling characteristics.

Hardware must be chosen or designed to connect the tubes together. The hardware design will determine, or be determined by, the



COMPUTER MODELS PREDICT AIRFOIL LIFT AND STABILITY

procedure employed to set up the glider for flight. Most parts are custom designed—in the form of stamped, extruded and/or machined fittings—to serve the precise function required in the optimum fashion. Hardware design must take into account adequate strength, durability, reliability and ease of use. Parts must be prototyped and field tested to insure that they will operate properly in all anticipated conditions, and that they can withstand moderate levels of abuse in service without failure.

Air*foil Selection:* The shape of the airfoil (the cross sectional shape of the wing if you cut through it in a direction parallel to the keel tube) has a lot to do with how the glider flies. The depth of the camber or thickness of the airfoil, the location of the highest point of camber along the chord length, and the specific curve that the top surface of the wing follows along the chord from front to rear will affect the pitch stability, the lift and drag characteristics of the wing, as well as the separation and stall characteristics. The designer may chose a slightly different airfoil for each spanwise station. Once the airfoil is finalized, jigs need to be designed for fabricating the preformed battens that will define this airfoil shape.

It is said that back in the early seventies when Dave Cronk showed up at Torrey Pines with an early prototype of the Quicksilver rigid wing hang glider, an engineering student from the local university pointed excitedly to one of the aluminum ribs and said something like:

"Hey, is that the new Liebeck LA 5055 airfoil!?"

To which Dave replied something like, "No, that's an HS235/14."

"I never heard of that one. What is it?" asked the student.

"That's the size of the tire I bent it around," replied Dave.

Sail Design: The design of the sail is the most complex single aspect of hang glider design. A hang glider is a unique type of aircraft, because the wing is so elastic. The frame is flexible, and the sail stretches elastically under the loads of flight. The leading edge of the airframe bows both inward and upward into a complex curved shape under the normal loads imposed by the sail, and the sail must curve to conform to this shape. The pre-shaped aluminum battens induce a curved, cambered shape into the top surface of the sail along the chord length, and the material must conform to this curve as well. The sail also twists under flight loads, further complicating the resulting shape. All of these complex curved shapes and surfaces must be cut and sewn into a material, the sail cloth, which is originally flat. The sail is made up of a relatively small number of separate panels of this flat cloth. Careful and precise shaping of the individual pieces of cloth that make up the panels in the sail, and highly accurate joining of these panels, is required to achieve the desired final shape of the sail. In designing the shape of each of these pieces, careful consideration of the stretch response of the fabric to different loads must be taken into account. Different weights, and different finishes on the fabric, will change its elasticity, its strength, and its ability to resist UV deterioration, and therefore each panel must be analyzed in terms of these requirements before the specific fabric for that panel is selected. Extra reinforcement must be added in areas of very high localized stress, or in areas where wear and tear is a problem.

Auxiliary Systems: Auxiliary systems must also be designed. These might include such things as a VG (variable geometry) system for the in-flight adjustment of sail tension and twist, or auxiliary stability systems such as reflex support bridles or washout tips.

Second Try — Optimizing The Configuration and First Prototype

After the general configuration is settled on, the design details must be worked out. This means looking at each aspect of the design and making a final choice about how to best optimize the glider for the intended market. Once this is done, a first prototype can be built and flown.

The next phase is the evaluation of the prototype to see whether it meets the original design goals. It is normal during this phase to experiment with a wide range of adjustments in tuning parameters such as sail tension, hang

point location, reflex and dihedral levels, and batten shape. This flight testing is critical to make sure that the glider flies the way the designers want it to. The overall quality of the finished product will depend very heavily on how thoroughly this developmental phase is carried out. No amount of theoretical analysis can substitute for actual flight testing of the glider in a wide variety of conditions, as the results of flight testing may be quite different from those anticipated during the initial design process.

Another Tom Price story concerns a revolutionary flex wing design Tom came up with during the late seventies. At that time it was recognized that external cable bracing, which included leading edge bracing deflexor systems, contributed greatly to performance-destroying drag. Another drag culprit was the external crossbar, and early attempts to enclose it in the sail were generally unsuccessful. Tom's idea was to substitute (for the cable rigging, supports and crossbar of the conventional glider) struts below the wing, and a massive, rigid noseplate from which large-diameter, tapered composite leading edge spars would be cantilevered. The glider was a radical departure in configuration from anything that had been tried, and Tom's analysis indicated that the performance gains would be tremendous. His only doubts were whether the unique structure would allow enough flex in the sail to provide adequate handling response. We ran into him shortly after he had built and flown the first prototype, and the conversation went like this:

Us (interested): "So, you've got it flying now. How's it working?"

Tom (mildly discouraged): "Well, not so good."

Us (knowingly): "What's the matter, it doesn't handle?"

Tom (bemused): "No, it handles fine, it doesn't perform!"

Tom never was able to solve the problem and obtain the performance level he was looking for, and eventually abandoned the project.

During the testing phase of the project the field testing of the hardware and set-up systems is accomplished, and the "dialing in" of adjustments for auxiliary tuning and stability systems.

Based on the results of the flight and field testing, changes will be made to the glider design. These changes may be limited to minor details of hardware design or frame or sail construction, or they may involve wholesale redesign of the most basic parameters of planform or airframe configuration. Following these changes a second prototype will be constructed and the flight and field test evaluation process will be repeated. This process of testing, modification, prototype building, and retesting will continue until the designers arrive at a flying configuration with which they are satisfied.

Pre-Production (Final) Prototype

Once a satisfactory configuration is achieved, the specifications are finalized and a final prototype is constructed. This glider will be built to the exact specifications which are intended for the production models, and serves as a final test of the configuration. A flight test program is conducted to confirm that this glider does, indeed, have the desired flight performance and characteristics.

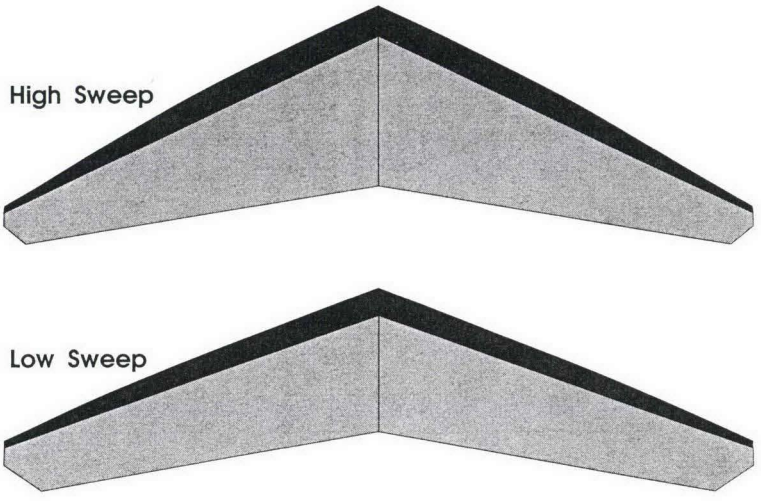
Vehicle Testing and Certification

The next step is vehicle testing and certification of the glider. The certification program administered by the Hang Glider Manufacturers Association is a program of manufacturer testing and certification to a set of standards which are set by the HGMA. The purpose of certification testing is to establish, by an objective series of tests, that the glider has a certain minimum level of airworthiness. The certification program is

PLANFORM

A high sweep planform has good yaw stability and damping, which makes it "track well" (consistently point in the direction it is flying without oscillations). This makes the glider easier to fly. However, for aerodynamic reasons related to the stall and spin behavior, high sweep requires high twist (loose sail tension) which hurts performance.

A low sweep planform allows for a much tighter sail, with much less twist, and therefore offers (theoretically) higher "pure" (L/D) performance. However, the handling will be more "slippery" and if the pilot doesn't have the skill to keep the glider smoothly under control the actual performance realized will be lower.



Anhedral and Dihedral

Most modern hang gliders have between 0 and 5 inches of anhedral, measured as the distance below the keel of a line off the bottom of the leading edge joining the leading edge / xbar junctions.

Anhedral, a downward fold of the wing about the keel axis, improves initial roll response and reduces adverse yaw on turn initiation. Excessive anhedral contributes to roll yaw oscillations at high speed.

Dihedral, an upward fold of the wing about the keel axis, improves high speed roll / yaw stability, but aggravates adverse yaw and lag in response on turn initiation.

entirely voluntary, and not every model from every manufacturer necessarily gets certified, but consumer demand for certified gliders has raised the level of manufacturer participation in the program to a very high level in recent years. The HGMA standards define airworthiness in terms of four measurable parameters: strength, stability, controllability and performance. Each requirement under the four parameters must be met by documented testing in accordance with the written HGMA Airworthiness Standards.

Performance is the easiest, and most basic. The glider must be shown to be capable of launching and landing safely, without the need for special or expert skill. It must be shown that the glider has a glide ratio of at least five to one, and it must be shown that the glider has a steady-state top speed of at least 35 mph.

The requirements for controllability include requirements that the glider be able to reverse a 45° bank circling turn in four seconds or less, that the glider can accelerate from stall speed to more than 30 mph in four seconds or less, and that the glider can be flown through all maneuvers incident to normal flying, including stalls, turns, slips, dives, takeoffs and landings, without loss of control or the need for expert or unusual skill.

The stability requirements are divided into two parts. First, it must be shown that in flight, throughout the full range of normal flight maneuvers, the glider is stable in pitch, roll and yaw—that is, that it will seek and return to a given trim speed (pitch stability), that it will inherently point in the direction it is flying (yaw stability), and that it will not arbitrarily steepen its bank in a turn (roll stability). On the test vehicle, it is required to show that the glider maintains positive pitch stability (the tendency to return to a specific trim angle of attack) across a broad range of angles of attack outside those of the normal flight envelope. This serves to insure that the glider will recover from a dive or resist a tumble even if the pilot's direct control over the glider has been momentarily compromised by turbulence.

The structural or strength tests are based on three vehicle tests. In the positive load test, the designer must first choose a maximum operating speed for which to placard the glider. Pilots are restricted by manufacturer recommendation to flying the glider at or below this speed. The minimum allowable value for this never-to-exceed speed is 46 mph. Then the manufacturer must test the glider at a speed 42% higher than this placarded VNE speed, and show that at the required test speed, when tested at its maximum lift angle of attack, the glider's structure will withstand the load without failure for at least three seconds. The purpose of this test is to simulate the load on the glider if it were flown at a high speed (at a low angle of attack), and then suddenly brought to a high angle of attack at this high speed—either by maneuvering (a pull-up from a high-speed dive) or by turbulence (a sudden, sharp-edged gust of vertical air flow). This is the mechanism which produces higher than normal loads on a glider structure, and a glider which passes this test should be able to be flown without fear of positive load structural failure so long as the placarded maximum speed limitation is adhered to.

The requirements for negative structural strength include a vehicle test at negative 30° angle of attack at the VNE speed, and a test at negative 150° angle of attack at 32 mph.

Once all these tests are performed, the documentation must be put together in the form of a video and written package and submitted to the HGMA board of directors for review. Among the requirements of the written package are a glider owner's manual, and a complete set of manufacturing specifications for the battens, airframe, hardware and rigging, along with a scale planform drawing of the sail. If the directors find the report to be complete, and in the proper format, an HGMA Certificate of Airworthiness is issued. The HGMA board does not make an independent determination of the accuracy of the manufacturer testing data (although it will do so if some subsequent incident calls the glider's airworthiness into question) but verifies only that the manufacturer has submitted complete documentation. The certification is, therefore, "by manufacturer declaration."

At the end of this process, the glider is ready to be put on the market. At that time, the final test of the designer's skills and level of effort will be made, as the marketplace passes judgement on the quality of the finished product. ■

Videotapes For Hang Glider Pilots

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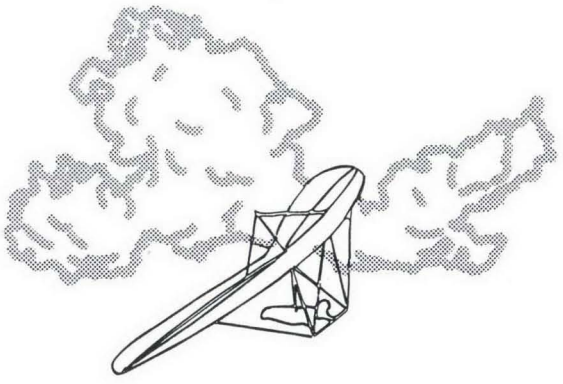

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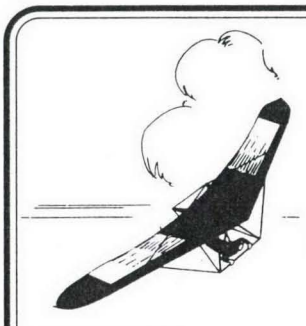

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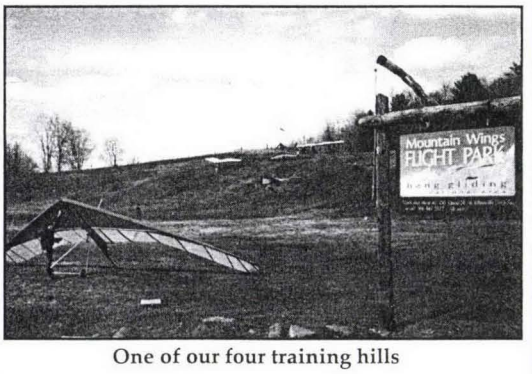

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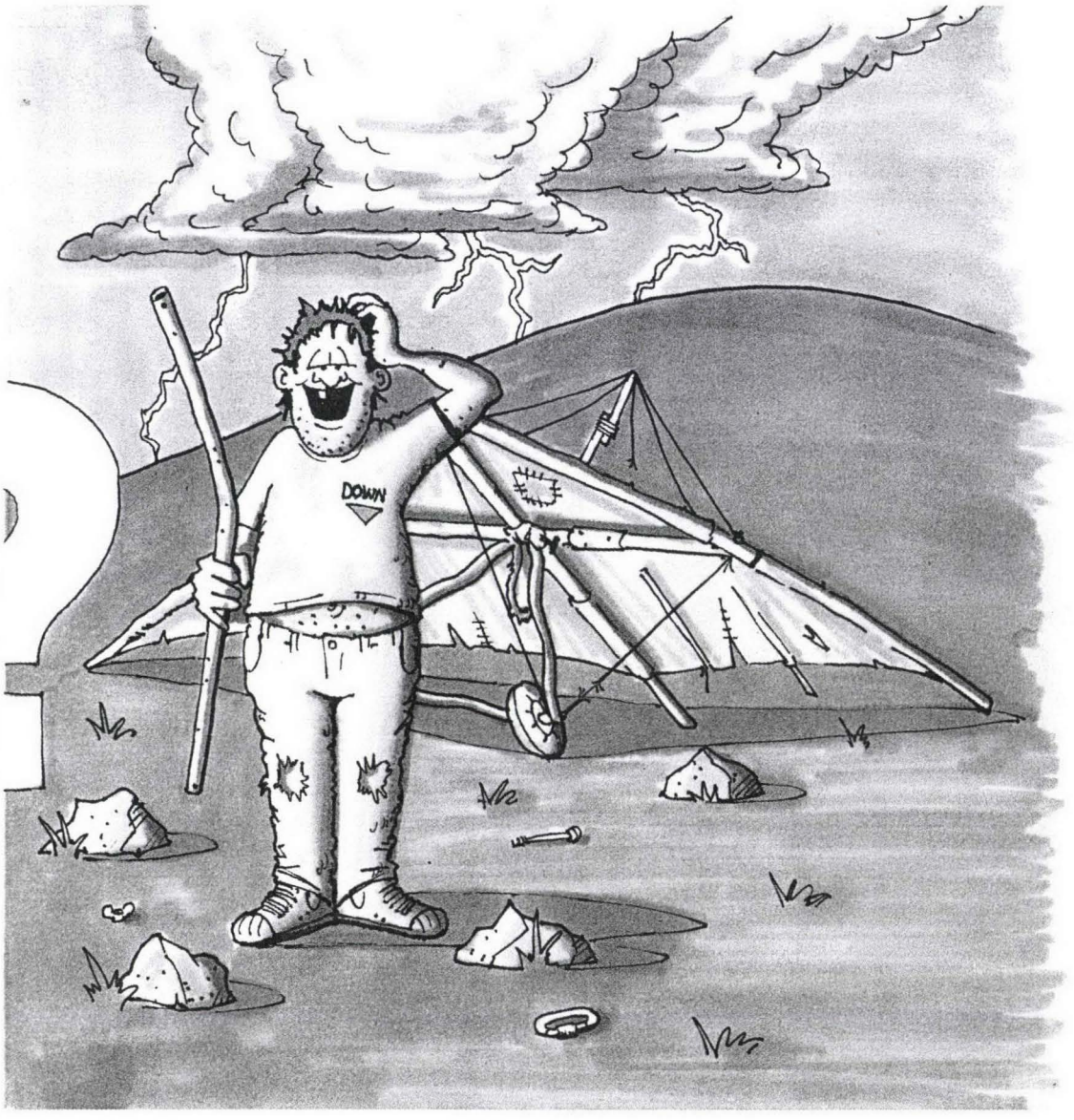
Choosing An Instructor/School



by G.W. Meadows

illustration by Bill "Tex" Forrest

Many of you reading this magazine have either just had your first experience with hang gliding or are considering it. Hang gliding is without a doubt the most exhilarating sport in which a person can participate, but sometimes a new pilot will have had a bad experience learning to fly that can be attributed solely to the instructor. The bad experience I'm referring to doesn't necessarily concern flying itself. Sometimes, although not very often, an instructor can be confusing, preoccupied or downright rude. This can leave a student with a bad impression the sport, and he is not likely to continue, so I'd like to point you in the right direction when it comes to choosing an instructor or school.

One of the most common mistakes prospective students make is to select a school solely on the basis of price. Just as when choosing a brain surgeon, look for skill first and price second. There are a number of "cut rate" hang gliding schools out there (although their numbers are shrinking) that are definitely the last place you want to learn to fly. For a professional school to stay in business, it *must* charge a reasonable amount of money for lessons. The gliders you abuse during your lessons will have to be replaced in time, and the money for that has to come from somewhere. No one—*absolutely no one*—is getting rich in the sport of hang gliding. The instructors who do it right are making somewhere between a paltry and a reasonable living. When considering the cost of lessons, remember: you get what you pay for.

The first thing you *do* want to look for when considering a hang gliding school is professionalism. Of course, the first thing to look for is USHGA certification. Hang gliding instruction is a business, so when checking out a school notice how professional the instructor or school is. Ask them what kind of equipment they use and why. Not all equipment has to be new, but if an instructor is using older equipment make sure he has a good reason for it (other than cost). Many schools must use older-style gliders because of the constraints of their training facility. Older gliders don't glide as far as the newer ones, and they may be used in training areas where the size of the landing zone

is a concern. Other schools may use more up-to-date equipment, so the student will be able to transition to his own new glider with little or no need to relearn some basic flying skills.

Another way to judge professionalism is by how you are dealt with over the phone. If you are treated like a customer and not someone who is a bother, you can figure that this person sincerely wants your business and cares about you, the student. If the prospective instructor answers the phone professionally and is able to carry on an intelligent, informative conversation, satisfactorily answering all your questions, you will want to consider him further. If he is short with you, or if you feel you know no more after hanging up the phone than you did before, rule this guy out as your new instructor.

Another good way to find out where to take lessons is to go to the nearest (and sometimes only) flying site, and ask as many pilots as you can where to take lessons. You'll learn an incredible amount about the folks you're considering dealing with from the people who have already dealt with them. Don't make a judgement on the basis of one person's bad experience, but if you hear numerous bad reports about a particular instructor you should be cautious.

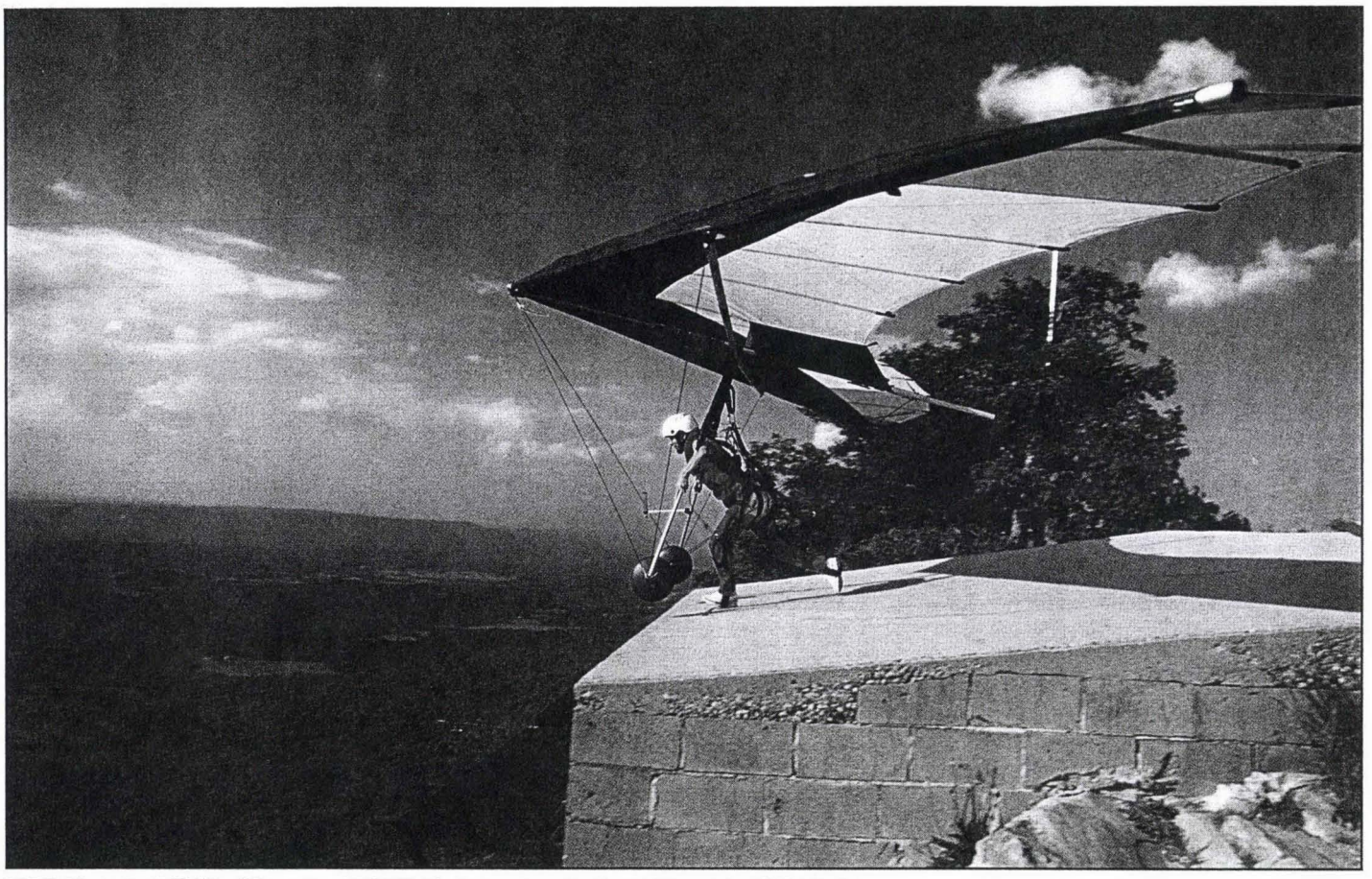
Setting business hours and sticking to them is another indicator of professionalism. Not all schools have to be open five or six days a week to be effective, but when considering the choices remember that you not only want instruction, you want someone whom you can contact on a regular basis to ask questions and get advise about learning to fly. An instructor should be there for you.

Manufacturer support and representation is a must. If the school you are considering does not represent a manufacturer's line of gliders, that should be a clue that the school wasn't professional enough for a manufacturer to allow them to sell its gliders. However, just because a school *does* represent a manufacturer doesn't mean that it *is* professional. You'll still need to check them out.

Another consideration is how many pilots the instructor or school turns out. A school that is no good will create few new pilots, while a good one will turn out a respectable number; this is a good gauge of an instructor's skill.

Don't pass up a school just because it's new. Obviously they will not have a track record, but the instructors they've hired or the instructor who started the school will have one. In this case, check into the instructor's background. Check *Hang Gliding* magazine for ratings issued by a particular instructor; this will be an indicator of his experience and professionalism.

I hope this has been helpful. With just a little investigation you can determine if the school you're considering is the place to learn hang gliding. Use common sense and not your bank account as the deciding factor and you'll do well. Good luck in your flying career, and welcome to the most rewarding experience you'll ever have. ■



LEFT: Photo by Bill "Tex" Forrest. ABOVE: Photo courtesy Lookout Mountain Flight Park

Your First Mountain Flights

by Buzz Chalmers

It's a big step. Some say it's more like a leap of faith. But one thing's certain: you'll remember your first mountain flight for the rest of your life.

If you're already a student on the training hill, no doubt you've experienced the feeling that *you're actually flying!* For a few tantalizing moments you're free, floating above the ground. Your goal, of course, is to extend those brief moments into minutes and eventually hours! That's what mountain flying is all about.

I remember my own first mountain flight as if it was burned into my neural pathways. Soon after launch, the earth dropped off below me, and I floated effortlessly in the gentle air. I relaxed, and the glider seemed to fly itself. The gentle sound of the air moving past my glider was almost too comforting.

For the first time, I entered an almost undiscovered world, a magical realm shared by the birds and hang glider pilots. No longer was the ground close by, my feet securely planted on it. Everything was far away in this huge expanse of three-dimensional space. The feeling of peace and serenity was overpowering, and I remember thinking, Wow! *Nobody told me it would be like this!*

The comfort of familiar up-close surroundings was gone, replaced by an incredible freedom and exhilaration, an almost indescribable feeling. Intense. Powerful. Almost mystical. Words just don't do it justice. *This is really flying!*

Getting to fly the mountains is what learning to fly a hang glider is all about. There's a lot you need to know to become a safe, proficient hang glider pilot.

This article is intended as a general introduction to some of the many things you'll need to know on your early mountain flights. It is not intended as a How-To guide to teach yourself. Your instructor will add more information of his own. Much of the following information is taken from the Mountain Ground School written by Lookout Mountain Flight Park, near Chattanooga, Tennessee, where I teach and work.

Novice Rating

Before you fly a hang glider from a mountain, I recommend you earn and be issued your USHGA Novice Pilot rating (called the Hang II rating by "old-timers"). Your instructor should be at least a Basic Instructor, certified by the United States Hang Gliding Association (the

governing body for our self-regulated sport). USHGA Basic Instructors are authorized to issue Beginner (Hang I) and Novice (Hang II) pilot ratings, after you pass the appropriate flight test and oral/written test. The Novice rating is the minimum rating I think you should have before you make your first high-altitude mountain flight.

Some mountain sites are more difficult to launch, fly or land, and require an Intermediate (Hang III) or even Advanced (Hang IV) pilot rating. Many mountain sites throughout the U.S. are only informally regulated (or not at all)—this doesn't mean they are appropriate for your first mountain flights. Be cautious any time you are learning something new, such as flying a mountain, in hang gliding.

High Anxiety

It's perfectly normal to be a little nervous about your first mountain flight. It *is* a big step. But you shouldn't be overly fearful. Remember, a hang glider has no eyes. It doesn't know or feel the difference between 50 feet and 1,000 feet above the ground. The glider will fly exactly the same at either altitude. If you can fly successfully from the training hill, you can fly the same way from the mountain. (High-altitude flying at higher Mean Sea Level altitudes where the air density is lower is another subject.)

If you are extremely nervous about your first mountain flight, talk it over with your instructor. More training hill flights may be advisable, or perhaps a tandem flight from the mountain with an instructor.

Waiting On The Weather

A very important part of every instructor's job is judging (and teaching you to judge for yourself) the wind conditions appropriate for your skill level and the task you are doing, whether on the training hill or the mountain. New mountain pilots should fly only *in the best (lightest) of conditions*, as they have yet to experience the adverse conditions they'll later learn to fly in. I recommend you get your instructor's okay before you fly; an experienced opinion about whether the wind conditions are appropriate for you will enhance safety and lessen your anxiety.

Calm air or very light smooth air on launch, and little or no wind in the landing field are requirements for safe first mountain flights at most sites. No thermal activity (gustiness or turbulence) should be present at the time, and none expected to develop. Periods of the day when thermal activity is normal should be avoided. Judging wind conditions in the landing field always involves an educated guess as to what will occur five minutes, 10 minutes or 15 minutes (however long the flight will take) into the future.

First mountain flights should be limited to sled rides: launching and gradually descending to the landing field. Soaring flights (staying above the mountain or valley for extended periods of time) will come later, after more mountain flying experience has been acquired.

Learning To Fly

by Tom Anderson

It is a little after 7:00 AM and the cool morning air wafts up from the still valley over a thousand feet below. I am rigged in helmet and harness, hooked into my hang glider and poised at the edge of a steep launch. This is the first time I have ever launched from the mountain and it represents the culmination of my hang gliding training. It is the defining event that separates hang glider pilots from everyone else. It probably requires more confidence and self-control to make this single flight than any other experience one can have in the sport. From far below an observer crackles up on the radio: "All clear down here in the landing zone. It's your call."

Getting to this point does not happen overnight. The training necessary to achieve this flight is considerable, and requires real commitment. I didn't know this when I started out. But last year, when childhood dreams of flying started recurring with persistent regularity, I knew it was time to try out this sport which promised to bring me as close to the experience of the birds as I would ever get. The sport is refined, elegant and pure. The aesthetics of hang gliding will appeal to anyone who has ever seen those flex-wing craft swoop and hover.

Of course first comes the training. Although several shops and individuals offer instruction, in the New York metropolitan area Mountain Wings is the largest and most complete. This shop is located in Ellenville, about a hundred miles north of New York, and is operated by Greg Black, a Master-rated pilot, and his wife Judy, who provide all the equipment and training needed for involvement in the sport at any level. I found the instruction to be of high quality and appreciated the large amount of individual attention their programs provide.

Many people get started with the entirely misguided notion that after being checked out on the equipment and a couple of lessons they will be ready to fly cross-country. This is not the case. What you will get with your first set of day-long lessons is a thorough introduction to the sport and enough experience to determine if hang gliding is for you.

Training is structured and designed to get you flying with a minimum of pain and fear. First one exercises on a training simulator, learning the controls and to do exactly what the instructor tells you. With alarming frequency students will push the control bar out upon receiving the urgent instruction "Pull in!" On landing this can result in a premature stall and nose-first descent known technically as "whacking."

Next comes ground training wherein the student is strapped into a hang glider and hustles along at ground level, learning the feel of the wing as it lifts off his shoulders. From there it is on to the training hill where the fun really begins. Though basically quite simple, controlling a hang glider is not immediately intuitive, and the antics that occur as student after student discovers this can be quite amusing. Being heavier than air, a hang glider will promptly return to earth in a variety of unexpected ways unless properly handled.

Eventually, however, everyone with enough coordination to chew gum and flap their arms at the same time gets the hang of it, and as skill and confidence increase they are allowed to launch from higher and higher points on the training hill. One important part of the process, which is definitely not shown in the promotional videos, is lugging the glider back to the top of the hill under a blazing sun. Although lightweight, training gliders are guaranteed to be the heaviest 50-pound load you will ever haul.

At this stage one also learns the key concept of the "hang wait." If the wind is gusty, variable, too strong or crossing, or if it rains or the weather acts in any way less than ideal, the student is obliged to hang around and wait for conditions to change. Chants and dances to weather gods are deemed unseemly, especially at the student level, so mostly the student gets to learn the lies and lore of hang gliding. The two instructors at Mountain Wings, Bill Umstattd and Frank Valenza, are well suited to this task. Bill is trained as an aeronautical engineer and can explain down to the minutest detail exactly how it is that these gliders keep us in the air. A certain twinkle lets you know that somewhere deep inside him the soul of a falcon lurks, turning on a widening gyre. Frank is more voluble and passionate, and an excellent flying teacher. You get the feeling that he really wants to keep you in one piece.

When your average terrestrial contemplates the prospect of dangling from a skinny strap below a dacron wing thousands of feet in the air, the reaction is that the sport must be profoundly dangerous. As reasonable as this may seem, I feel that it is actually quite safe. Improved equipment, rigorously-structured instruction and keen attention to safety by the U.S. Hang Gliding Association have dramatically improved the sport's safety record. Hang gliding has largely shed its previous image of a sport for maniacs and daredevils. On the whole, hang glider pilots tend to be a surprisingly responsible and relaxed group.

To get beyond the beginner stage it is necessary to purchase a glider. Although I railed at this, six months of looking for a rental without success convinced me that there is no way around it. New gliders start at about $2,500, or you can figure at least $1,400-$1,500 for a decent used one plus another $600-$700 for the harness, parachute (necessary for all mountain flights), and helmet. Not included in this is the vehicle and chauffeur needed to shuttle you from the landing zone back to the top.

However, the real commitment necessary to hang glide starts to reveal itself at the advanced training hill, where the vertical drop of almost 200 feet translates into an involuntary weight loss program on the uphill haul. To make matters worse, due to the vagaries of geography and microclimate, suitable conditions seem to appear only around 6:00 AM. Of course there is no guarantee of this and one may well participate in several indecently early coffee klatches waiting for conditions to improve. On the advanced training hill the student gets a real taste of flying, learning turns and more advanced flying techniques. The student also learns of the unnatural attraction between hang gliders and cow pies, and how deceivingly dry a swampy landing area can appear from the air. Though you can get the necessary skill and experience in six or seven flying days, most beginners will spend weekends for a couple of months preparing for their first mountain flight.

After completing all these hurdles and passing a written test, I am ready for my first mountain flight. Frank is below on the radio. Bill is helping on launch and goes through a complete pre-flight check of all the equipment. Weather conditions are ideal. I hoist the glider and note that my sweaty palms seem slippery on the tubes. My mouth is cotton dry. All eyes are on me. I suck in my queasy gut, adjust the glider to the correct pitch, bark out "Clear!" and begin my run down the launch. Within moments the glider is tugging me off the ground and I am swept into a breathtaking and deeply exhilarating rush of wind and space. I try to focus on the task at hand but feel overwhelmed by the majesty and awesome spectacle of the moment.

The radio interrupts my revery, "You're going to want to try a right turn now," and I am glad to have some instructions to follow. After the first couple of turns I settle down. I am really flying and, despite a certain wobbliness in the knees, am doing fine. The glider slips and floats, and the gentle pressure needed to control it seems as natural and unhurried as a slow dance. Far away the farmers are starting their day. Birds skim the trees below, a gentle rustle sways the fields and the liberation of flight becomes real. I feel the beautiful rushing wind. At last I begin my approach to land but am too dazed to do anything but follow instructions coming from the radio. Frank is good. He gets me down in the middle of the landing area, a virtual bull's-eye.

I run my glider over to the side of the field, unhook the harness and give Frank a big hug. There is much congratulating all around. Frank turns to the others and says, "Look at him. He'll get that grin off his face in about a week." ■

Tom Anderson is an architect and developer who lives and works in Brooklyn when not scouring the streets of Ellenville looking for a qualified observer to help him launch off a mountain.

The Same's The Game

Remember the cardinal rule in hang gliding: *never do more than one new thing at a time.* Your first mountain flight is one new thing (it's a new site for you). Everything else should be the same familiar and comfortable variables: same glider, same harness and helmet, same wind and weather conditions you're accustomed to flying.

When you get cleared by your instructor to fly the mountain, remember that, in a sense, you are once again a beginner. Just about everyone you will be flying with (other mountain pilots) is more experienced than you.

It's important that you retain the same positive attitude toward safety and learning that earned you your success on the training hill. Learn as much as you can from talking to (and listening to) the more experienced pilots around you. The local pilots at a site are often the best source of information on flying there.

What's The Plan, Man?

Before each flight, go over your flight plan with your instructor. Your flight plan should include each step of your flight: the launch (What's the wind doing at launch? What are the steps of a successful launch?), the flight (What conditions do you expect during the flight? Will you have to crab into a crosswind to make the landing field? What speeds will you fly?), and the landing (Is there any wind in the landing field? What direction? What is your planned landing approach? How will you land the glider?).

Focusing on each part of your flight allows you to avoid surprises once you get there. It's usually best to stick to your flight plan unless safety considerations dictate a change. If you have questions about anything, ask your instructor before you launch—that's what he's there for.

The Launch

The most important factor of every launch is controlling the angle of attack of the wing (the angle at which the nose of the glider is elevated, sometimes called the nose angle) as you accelerate the glider, referred to as "controlling your nose angle." Many launch problems begin with improper control of the glider's nose angle. Of course, keeping your wings level is important for launching straight and flying away from the mountain.

There may be slight differences in mountain launch technique compared to training hill launch technique due to the physical differences between sites. You may be launching from a ramp on the mountain, instead of slope launching as you did on the training hill. Your instructor will advise you of any differences.

The Flight

After launching successfully, the first thing to do is be sure the glider is flying (be sure you have proper airspeed), and you're headed in the proper direction away from the mountain. Fly toward your landing field, so you arrive with plenty of altitude to set up your landing approach. The landing approach pattern you use will depend on your instructor and the size and shape of your landing field, as well as obstacles to avoid, etc.

If there's a slight crosswind, you may have to "crab" the glider to fly straight to your landing field. Crabbing means pointing the nose of the glider into the wind to compensate for the wind pushing the glider downwind of the landing field. Exactly where the glider's nose is pointed is not critical. What *is* important is where the glider and you are tracking (flying), which should be your landing field.

Just as you were taught on the training hill, look ahead toward where you want to go, not directly down at the ground below. Fixating on the ground below may cause you to inadvertently drift off course without knowing it, or overcontrol the glider (oscillate side to side) if you're flying too fast. If you look ahead to a point on or below the horizon, you'll relax and make smaller, slower movements on the control bar to initiate minor course corrections.

Speeds To Fly

After you've successfully launched and you're well away from the mountain and at least several hundred feet above the ground, relax your hands and let the glider find trim speed (the airspeed at which the control bar wants to remain stationary, neither moving forward or back). It's important to find trim speed because it is a good reference point for your speeds to fly.

If the glider is trimmed properly, trim speed will be neither too slow (too close to stall speed) nor too fast. The actual airspeed at trim may vary from glider to glider, depending on design and wing loading (how heavy you are on the glider). Finding trim speed allows you to relax and realize that, yes, the glider does fly the same off a mountain as from a training hill.

A common mistake made by first mountain flight flyers is to fly too fast. Despite being taught the difference between groundspeed and airspeed, subconsciously they see the ground far below moving more slowly than they're used to—it appears to move more slowly simply because they are so much higher above it. They "instinctively" pull in on the control bar to speed up. This leads to overcontrolling the glider.

Remember, the glider flies due to airspeed: the velocity of the air moving from nose to tail of the glider. How fast the ground below is moving (groundspeed) is irrelevant to the glider. Finding trim speed helps new mountain pilots overcome the tendency to fly too fast.

At Lookout Mountain Flight Park, we provide new mountain pilots with an airspeed indicator, and instruct them to fly in the range of 20 to 25 mph during the final 300 feet above the ground of their landing approach. This keeps their airspeed in an acceptable range for turning (even downwind if necessary). It also keeps them from subconsciously thinking that groundspeed is airspeed. (We also instruct them to ignore the airspeed indicator if it is obviously giving a false reading. Flying a hang glider—even with an airspeed indicator—is still seat-of-the-pants flying, not flying by the numbers.)

Porpoising

If your glider is trimmed improperly too close to stall speed, it may begin to "porpoise" if you fly at trim speed. At trim, the glider's nose rises too high (too high an angle of attack), the center section of the wing begins to stall, the nose drops and the glider loses altitude. Airspeed increases and the glider gains a little altitude as the nose rises again, and the cycle is repeated, like a porpoise jumping out of the water over and over again as it swims beside a ship.

If your glider is porpoising at trim speed, you'll need to fly the remainder of your flight pulled in on the control bar a little to avoid stalling.

PIO's

It's very important to relax your hands and arms. Tensing up may cause you to pull in on the control bar and fly too fast, possibly causing you to overcontrol the glider and enter pilot induced oscillations. PIO's occur when you do too much to correct a turn, causing the glider to turn the opposite way, followed by another overcorrection leading to another turn, etc. The cure for PIO's is to relax and do nothing—let the glider stabilize itself, then slowly turn the glider back on course if necessary.

What If It Won't Turn?

If you're trying to turn the glider but it just won't respond, you're probably either flying too slowly or cross-controlling.

Without enough airspeed, the glider will feel sluggish and slow to respond to your roll

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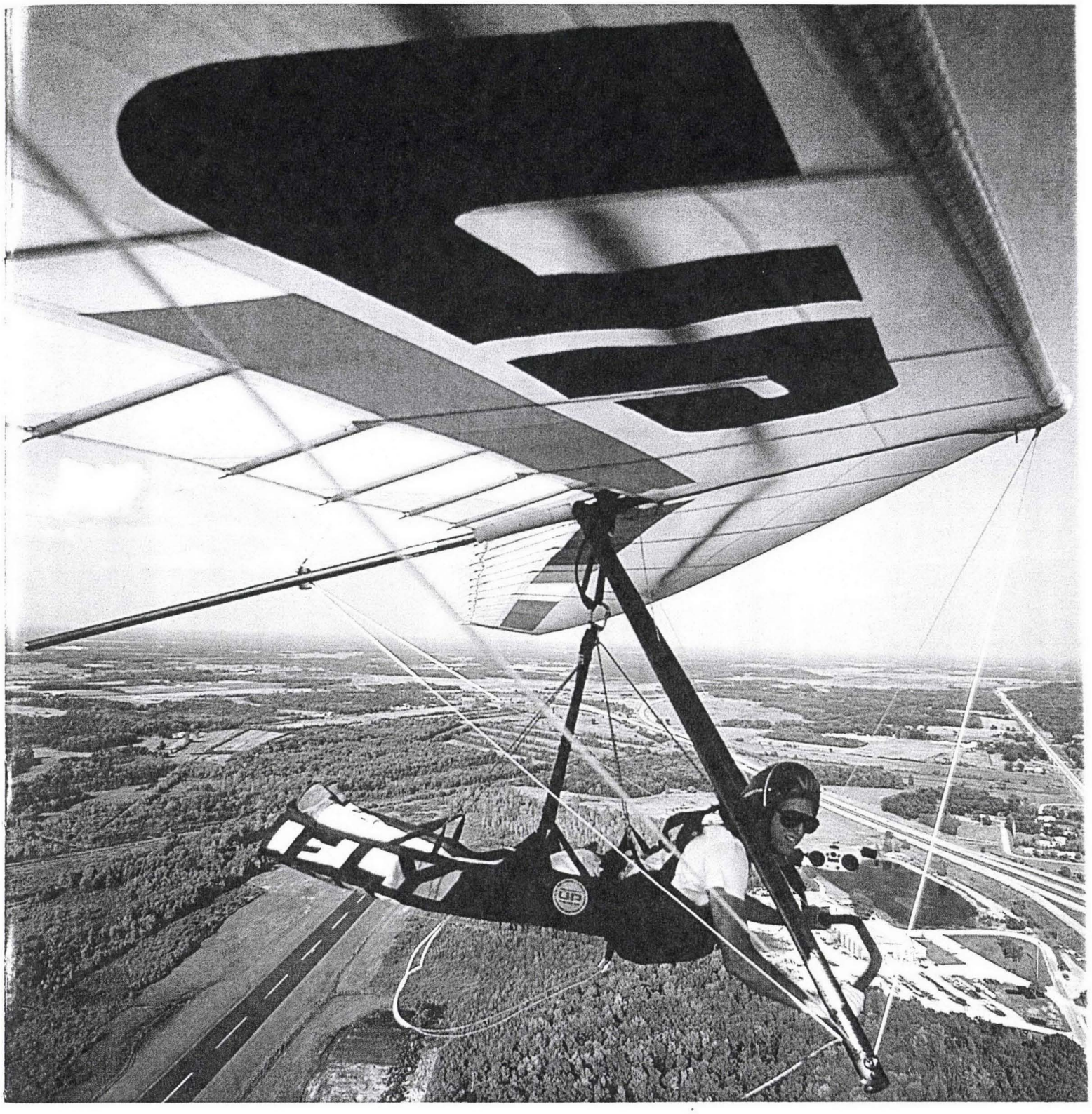

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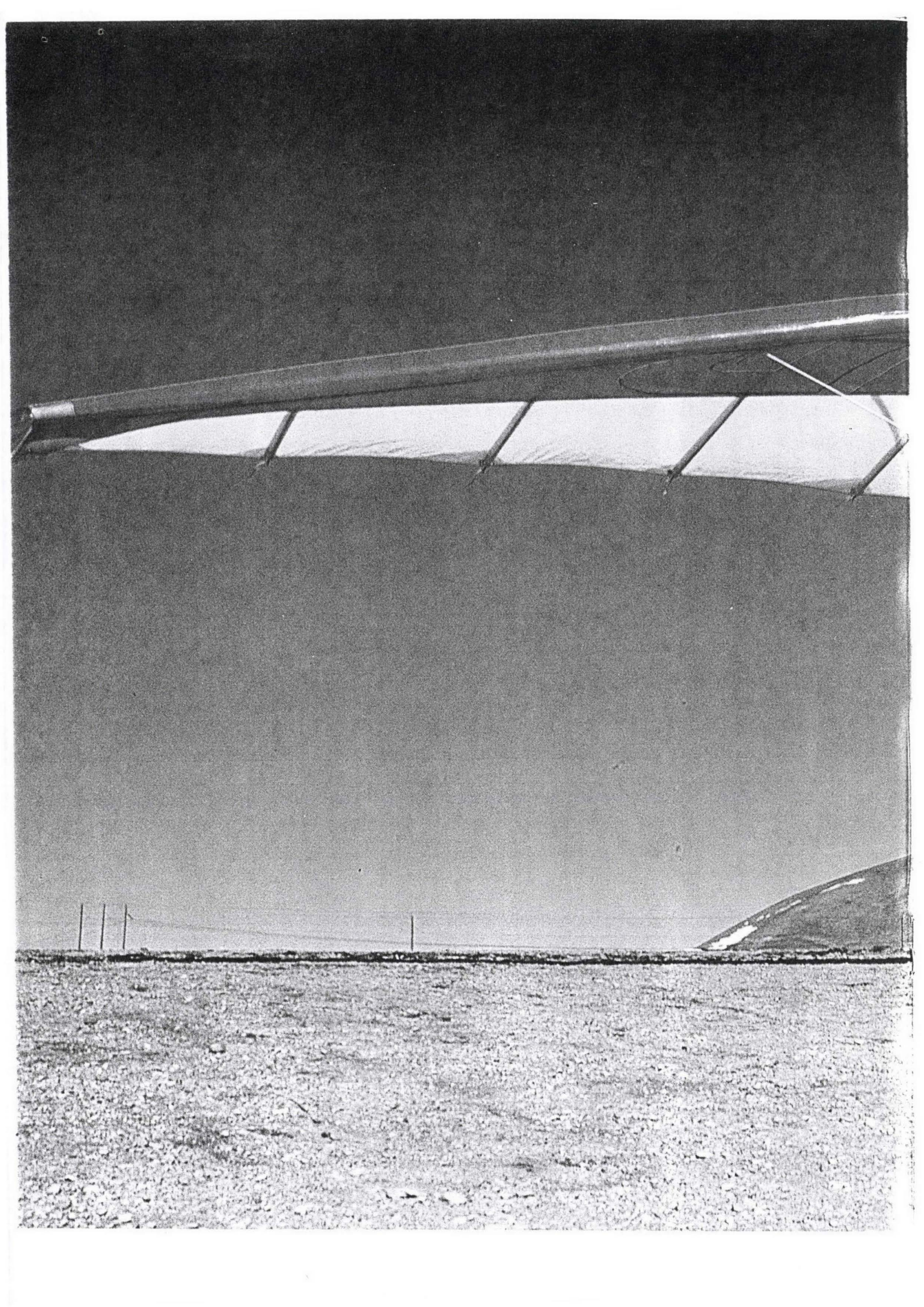

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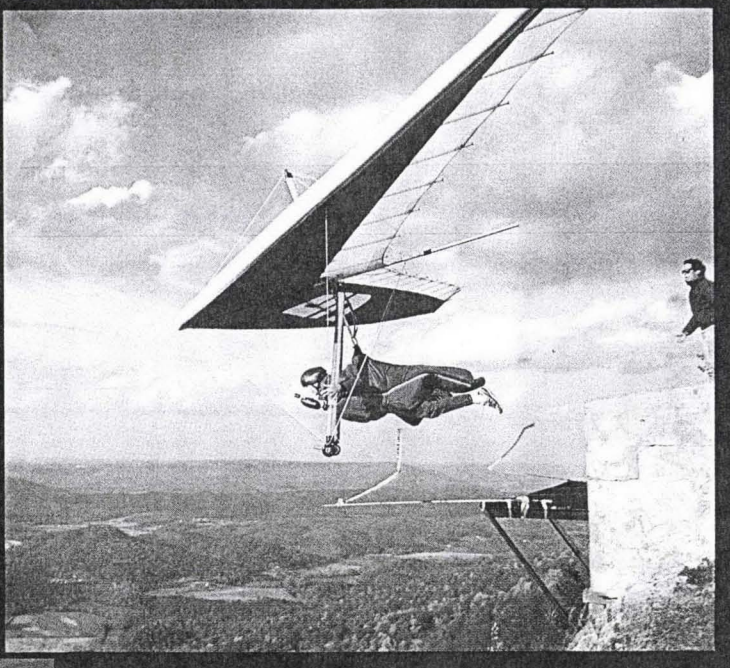

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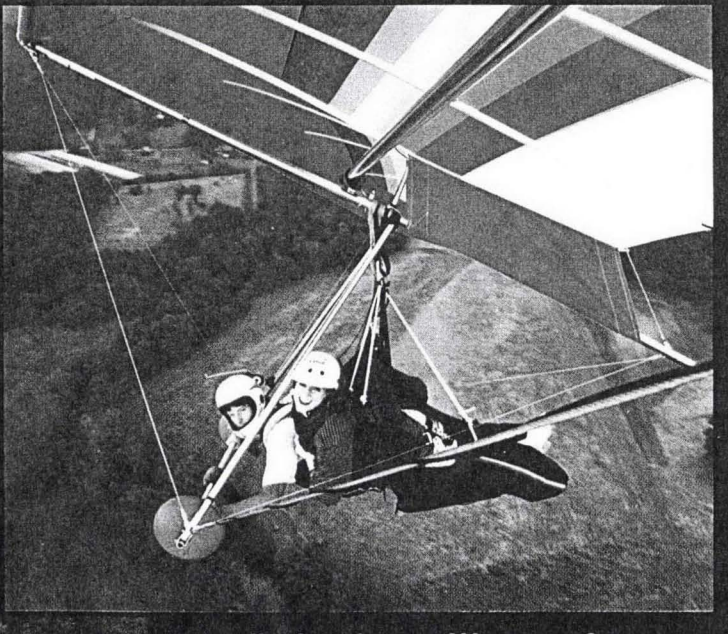

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input (moving your body to one side). If you "fly" too slowly, the glider won't respond at all—you're stalled. Solution? Pull in and regain your airspeed.

If you move your head and shoulders to one side but allow your feet to swing to the opposite side, the glider may not respond at all. This is called cross-controlling: moving part of your weight one way and another part of your weight the other way. Although you have pivoted your body around the center of gravity (the hang strap you're hanging from), you haven't shifted your weight to either side, and the glider doesn't respond.

If you're having trouble turning the glider, ease in on the control bar a little *and* be sure you're shifting your weight properly to the side you wish to turn toward. Bumping your weight gently to one side is an effective method of accomplishing minor turn corrections. In general, the smaller and slower your turn inputs, the smoother your minor course corrections will be.

Maneuvers

During your early mountain flights, your instructor may have you practice certain maneuvers, such as 90° or 180° turns. Such maneuvers should be attempted for the first time only if you are above your landing field and have at least 500 feet of altitude. On your first several mountain flights, I recommend you practice only maneuvers (such as 90° turns) you have done successfully on the training hill.

All of your turns should be smooth, coordinated turns. I do not recommend slipping turns in your landing approach (near the ground or obstacles) until you have a lot more mountain experience.

Ground Rush

High above the ground, the world appears to slow down. Because you are far away from it, the ground seems to move more slowly beneath you. But as you descend in your landing approach, things will begin to speed up once again. Don't be surprised by the ground rushing by (called "ground rush"). The closer you are to the ground or an obstacle, the faster it will appear to move by you.

Stay Away From Obstacles

As you were taught on the training hill, look ahead of you to where you are going, but don't fixate on an obstacle. Pilots have a tendency to fly toward what they are looking at (it's called target fixation). If you stare too long at an obstacle, you may find yourself flying straight toward it.

During your landing approach (the last several hundred feet above the ground), don't look directly down at the ground beneath you. If you look straight down you may not notice a slight turn and may drift off course.

Look ahead to where you intend to fly or land. Be certain that you have enough clearance to avoid any obstacles, both while flying higher up and when you are on your final straight approach to landing. Remember: you have wings, and your wings extend about 15 feet on either side of you.

Land Safely

Finally, when you are on your final straight approach to landing, you're back in familiar territory. Your landing should be the same as on the training hill. At 20 feet above the ground, be sure your wings are level and prepare for a normal landing.

After your flight, discuss everything with your instructor. There's still a lot for you to learn about becoming a mountain hang glider pilot. Reviewing each flight can be helpful.

Sled rides off the mountain are a lot more fun than the training hill, and soaring flights are even better. Eventually, you'll learn to gain thousands of feet of altitude by circling in thermals—rising "columns" of relatively warmer air.

The exhilaration accompanying altitude is awesome. As you'll discover, it's a natural high that lasts long after you've descended back to reality. It's part of the explanation for why we fly. No wonder Icarus flew too close to the sun, melting the wax in his wings. Even the authors of Greek mythology knew a good thing—almost too good to be true. ■

—Buzz Chalmers has been flying hang gliders since 1976, and is an Advanced Instructor and Tandem 2 Instructor teaching and flying at Lookout Mountain Flight Park & Training Center.

If your goal is to become a mountain pilot, I recommend you choose a school (and instructor) qualified to assist you in reaching your goal. Reputable schools and instructors are both certified by the USHGA. Ask them about their credentials and experience. Ask them how many mountain pilots graduate from their program each year. (Each Novice rating issued by USHGA is published in *Hang Gliding* magazine, along with the instructor's name and the school.) Is your instructor an experienced mountain pilot? (Not all instructors are.)

I do *not* recommend that you try to teach yourself to fly a hang glider, or that you "learn" under the supervision of a friend who already flies (but does not teach hang gliding). Experienced hang glider pilots know what's good for them, but not necessarily what's good for you. They may be able to safely fly in certain wind conditions; you may not. They may, or may not, be able to demonstrate proper technique, but can they identify your problems before they become bad flying habits?

If your goal is to become a mountain pilot, you should also inquire about the mountain your school or instructor uses for first mountain flights. Some schools are located at such a mountain or use a mountain site nearby. If the mountain is far away, plan on doing some driving (and possibly waiting) for appropriate wind and weather conditions—you may not always be able to fly and probably won't know if you can until you arrive. If you haven't already learned to be patient "waiting on the wind" on the training hill, you probably will before your first mountain flight.

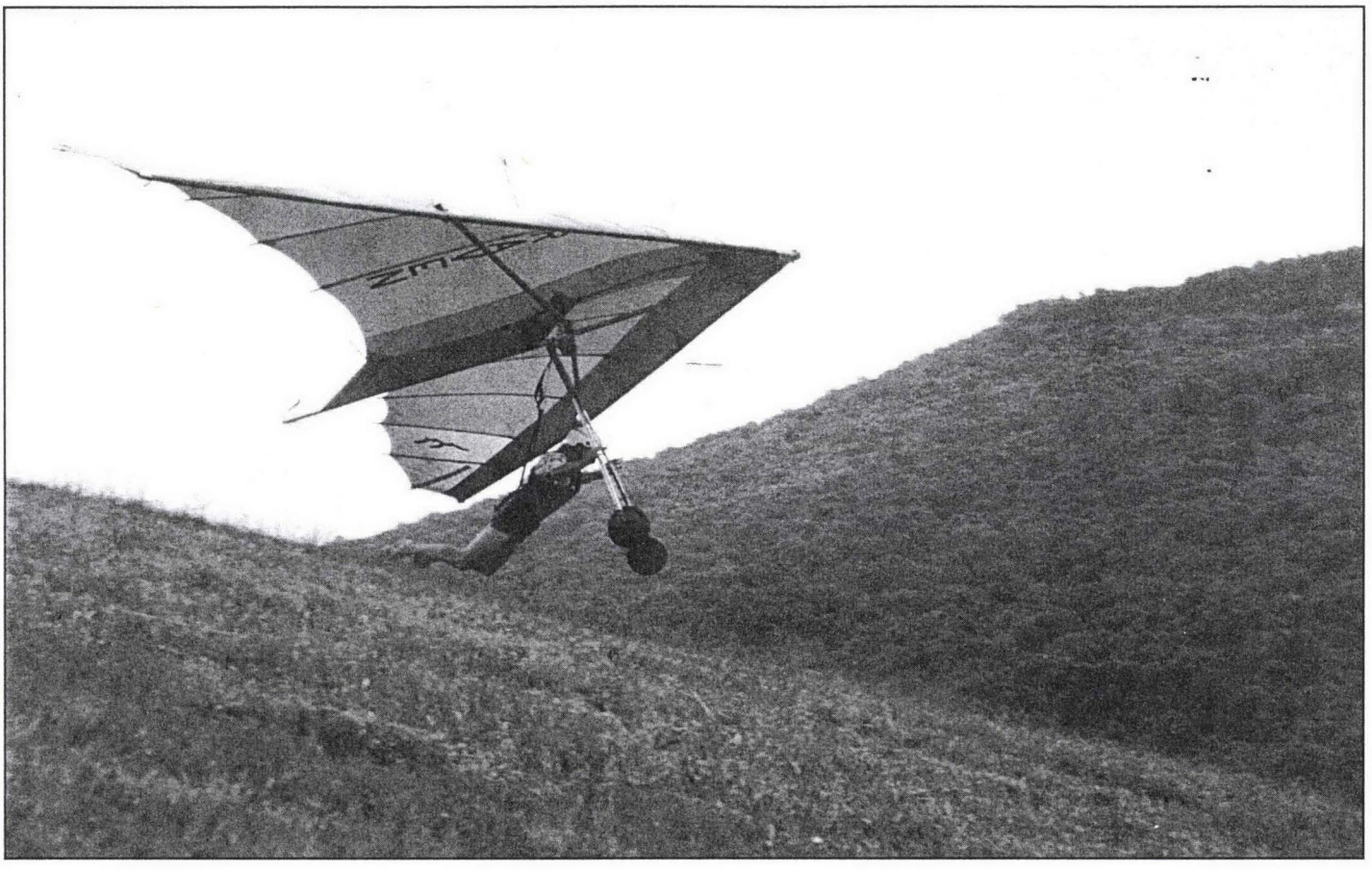
Site Of The Big Flight

It goes without saying, but I'll say it anyway: Some sites are *not* appropriate for your first mountain flights. Be certain that the site you fly is one where it is easy to launch, fly and land. The site should have the reputation for being appropriate for new mountain pilots (ask other pilots).

You'll have plenty to think about without having to worry about adverse site characteristics, such as too little clearance above the trees or ground immediately off launch, or too small a landing field, or a landing field too far away to reach if you encounter sinking air, or obstacles at launch or in the landing field.

If you're uncomfortable with something about the site, talk with your instructor about your concerns. If you're still uncertain about it, don't fly there. You have to launch, fly and land the glider safely. After all, it's your body hanging out there in the breeze. ■

Note the "two fingers" light grip.



Launching A

by Matt Taber

It's no secret that launching a hang glider is one of the most critical parts of hang gliding you will experience. You are accelerating in your run down the slope, the glider's nose angle is perfect, and the glider is trying to lift you off the ground. You run a few extra steps for insurance, and you're in the air. Even with an excellent launch you're (initially) only a few feet off the ground, you are close to stall speed and vulnerable to a turbulence-induced turn or loss of lift. Get the picture?

The takeoff phase of flight in any aircraft is critical, and deserves the utmost in practice and concentration. This is a key area where quality instruction can make a big difference. You should master this part of flying before moving on to turns, higher flight, etc.

For some students, learning to launch properly can be one of the most discouraging aspects of learning to fly a hang glider. Without a good launch, it's difficult to get airborne and have a good flight from a training hill.

Don't despair. With patience, practice and quality instruction, you too can learn how to properly launch a hang glider with consistency and confidence. Learning to launch correctly not only determines the quality of your early training hill flights, it also forms the foundation upon which the rest of your hang gliding experience will be built. Every flight requires you to launch, so there's a big payoff for getting it right.

Learning to launch should begin in a situation where there is little likelihood of actually getting airborne, such as in a ground school class taught on flat ground or a gentle slope. In this article, I'll use as an example the ground

Launching from the ramp at Lookout Mountain, Tennessee.

Hang Glider

school we teach at Lookout Mountain Flight Park, near Chattanooga, Tennessee. Other schools may use slightly different techniques, but the principles should be essentially the same.

You will be instructed to point the nose of the glider into the wind (if there is any). For a successful launch, the glider doesn't care whether the air moving over and under the wings from nose to tail (called *airspeed*) is provided by the wind, your running speed or a combination of both, so don't be intimidated by light wind or no wind. Any competent pilot should be able to launch in zero wind.

Holding The Glider

Holding the glider properly is extremely important. Equally important is using the correct size glider for your weight and body size. Even if you can hold the glider correctly, if it's too heavy for you, your ability to confidently and correctly launch will be diminished.

The best way to hold the glider is to wedge your shoulders between the downtubes of the control frame, fully extend your arms downward, and lightly grip the downtubes. For teaching, I prefer the grip we call the "bottle grip." Think of gripping a Coca Cola bottle by wrapping your thumb and forefinger around its neck and you'll get the idea. The downtube of your glider is the "neck" of the bottle.

With a little practice, you'll be able to balance the glider on your shoulders. It may feel awkward at first, but so did your first steps when you were learning to walk, or your first attempts at riding a bicycle. If you have problems holding the glider properly, there are optional hand grips that may work better for you—your instructor will help you with these.

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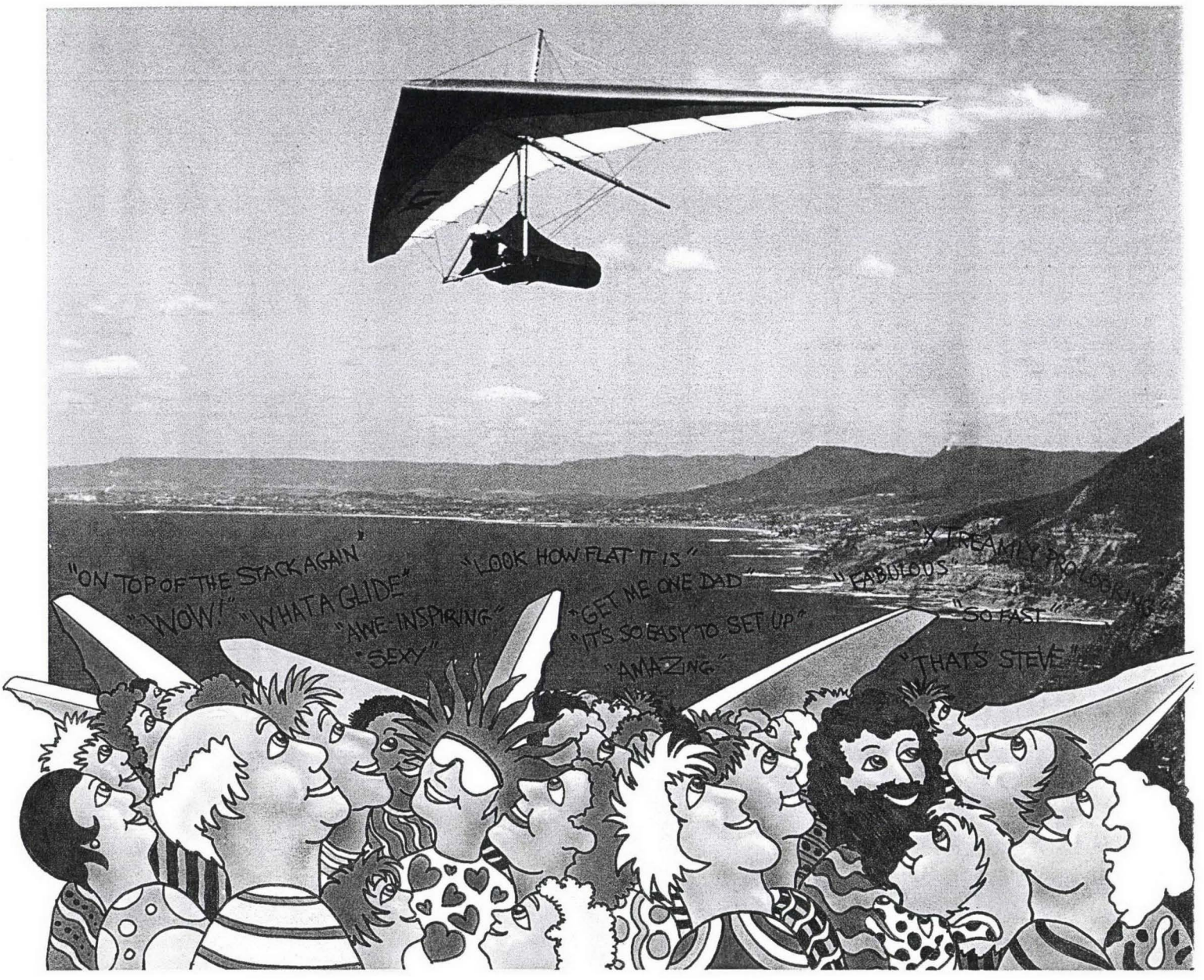

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MOYES XT

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Doing A Hang Check

The loose "bottle" grip.

The next step in ground school is to run with the glider using the harness. To establish good safety habits, any time we use a harness around a hang glider we must do a proper hang check. A lot can be said about hang checks and how to properly execute them. You should learn about hang checks by reading, watching and asking questions. You can read about hang checks—and everything else about learning to hang glide—in USHGA's official flight training manual, Hang *Gliding for Beginner Pilots,* available through the USHGA office and reputable schools. For now, your instructor will show you how to do a proper hang check.

One final note on hang checks: Do *not trust* anyone else to tell you "everything looks good" when you do a hang check. As the pilot, only you are responsible for a thorough hang check: 1) ensuring you have put on your harness correctly (straps aren't crossed or twisted, you're in your leg straps, etc.); 2) you're properly hooked in (attached) to the glider; and 3) you're hanging at the right height above the basetube. At Lookout, we recommend you do a final "walk through" hang check (as a double check) by standing up, stepping over the basetube and reaching behind you to inspect your carabiner and hang straps, then leaning forward in your harness and tugging on the whole harness/hang strap system.

Walk, Jog, Run

After you're hooked in and have done a proper hang check, lift the glider up (with your legs, *not* your back muscles), hold the glider lightly with the proper grip, look for traffic (other gliders or any other obstacle) and be sure your path is clear, focus on your target ahead, and slowly start to move forward with the nose of the glider into the wind. We like to tell our students to "walk, jog, then run" to smoothly accelerate the glider. Avoid "jackrabbit starts" (you're not doing the 40-yard dash), as accelerating too quickly causes some pilots to let the glider's nose drift up or down.

It's important to start moving forward slowly so you can concentrate on controlling your nose angle and keeping your wings level. Pilots who accelerate as quickly as they possibly can often lose control of the nose angle or inadvertently start a turn by slightly lowering a wing. If you start your first few steps slowly you can divide your attention between looking toward your target, properly controlling the nose angle and wings of the glider, and feeling the glider as it starts to lift off your shoulders.

After just a few slow steps, start accelerating briskly. Within the first five or six steps the glider will be lifting, and will become balanced and stable. Once the glider is flying and supporting its own weight, it's easy to increase your speed until you're running your fastest.

Concentrate on keeping the glider's nose angle where you are instructed, and keep your wings level. This sounds like a lot to do all at once, and it is—that's why we practice on level ground or a shallow slope. It'll become easier the more launches you do.

If your nose angle is set correctly, the glider will start to lift or fly off your shoulders almost immediately as your speed increases. Continue to accelerate, taking longer strides until you are running as fast as you can. As the glider starts lifting it becomes balanced, supporting its own weight, like a boat planing on the water.

Relax And Maintain A Light Grip

To feel this balance, you should relax and maintain a light grip on the downtubes. Tightening your hands or holding down on the downtubes usually causes the nose to rotate down a little, making your launch increasingly difficult. Try to relax your hands as the glider lifts off your shoulders, but keep the nose angle the same (don't let the glider's nose rotate up or down). Let the glider fly (don't hold it down).

As you run with the glider, you'll notice that raising or lowering the glider's nose has a dramatic effect on the way the glider feels. You'll discover there's a certain spot where the glider will plane (fly) smoothly through the air with little resistance and effort. If you raise the nose past this point by pushing out on the control bar, the glider will try to climb and slow down, and the glider will be a lot harder to run with. If you lower the nose by pulling the control bar back (or if you have a tense grip on the downtubes) as you run, the glider will accelerate ahead of you and may try to nose down into the ground.

You'll discover you can actually fly the glider while you are running with it. This is an important concept. You can control when it's time to take off by controlling the glider's nose angle. It's often said that your flight actually begins when the glider lifts off your shoulders—well before the glider lifts you off the ground.

Keep running until the glider lifts you away from the ground. It's a good idea to take a few extra insurance steps (try to run a little further), just to be sure you don't jump in the air before the glider is ready to support your weight.

Other Launches

What we have discussed so far is the generic launch. You may be wondering about differences in other launch disciplines, or launching in stronger winds.

In general, the steeper the slope or the stronger the wind, the lower you can set the glider's nose angle. You may even have the nose angle set below neutral, depending on the steepness of the slope and the velocity of the wind. Your instructor will advise you on this.

A cliff launch usually dictates a lower nose angle. Depending on wind speed and direction, and the length of the ramp, you may develop your flying speed after your feet have left the ramp. While this may not be suitable for your very first flights, a ramp launch can be one of the most forgiving launches you can experience. If you mistakenly pop up the glider's nose and stall, there is usually ample room (altitude) at many cliff-launch sites to recover and fly away, as long as you lower the nose. The same holds true if you jump into the glider too soon on a cliff launch: if the nose angle is set reasonably, the glider may dive a little on takeoff, but with flying speed and a little altitude, all you have to do is let the nose up to keep from running into anything.

The most important thing to keep in mind is that each launch site, whether cliff or flat slope launch, has its own peculiarities, and it's in your best interest to seek competent advice and/or instruction on how to best handle these new launch challenges. Observe other pilots launching. Note the techniques used by the smoothest pilots. Do not attempt to launch at a new site (for you) until you are confident you can safely launch your glider, recognize the differences, if any, of the launch, and you understand the best technique to use.

Currency Is Proficiency

For continued consistency and confidence in launching (as well as landing), you should adopt the attitude that "currency is proficiency." Most active pilots fly about 50 hours a year (or try to). If you average one hour per flight, that's only 50 takeoffs and landings each year—about four a month. It's difficult to be proficient in different kinds of launches with only four launches and landings per month.

The solution is the practice hill (a word I prefer to "training" hill). On the practice hill you can easily get six to 10 launches and landings in a short period, compared to flying off a mountain.

I believe all pilots should think of their local training hill as a practice hill, and all pilots should honestly evaluate their launch and landing currency and proficiency. Practice makes perfect. That statement takes on even more meaning when you consider that Larry Tudor, the world cross-country champ (at 303 miles in a single flight!)—even with all his experience and the many, many flights he makes each year—still practices. At a recent Kitty Hawk Kites Hang Gliding Spectacular, Larry was seen practicing flight after flight after flight, getting wired into the different type of launching, flying and landing necessary to be competitive at the sand dunes. We can all benefit from Larry's example: practice, currency and experience equals proficiency, safety, confidence and fun. You should get in the habit early in your flying career of practicing as much as you can, and keep that mind-set as long as you fly. Your rewards will be many.

More detailed information on launching and flying can be found in Peter Cheney's *Hang Gliding for Beginner Pilots,* as well as Dennis Pagen's *Flying Skills* and Erik Fair's *The Right Stuff for New Hang Glider Pilots,* all available through the USHGA office and reputable schools. ■

Matt Taber is owner of Lookout Mountain Flight Park & Training Center, located near Chattanooga, Tennessee. An Advanced-rated hang glider pilot with more than 1,500 hours airtime and Advanced-rated Instructor, Matt taught snow skiing and scuba diving before making hang gliding his life. He collaborated with Peter Cheney in writing and publishing the USHGA's official flight training manual, Hang Gliding for Beginner Pilots.

Don't Look Down

© by Dennis Pagen

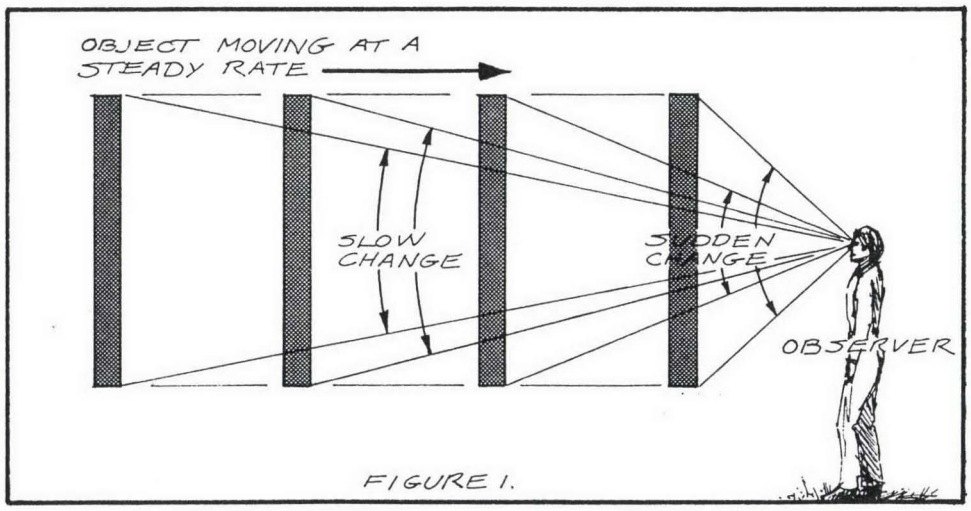


FIGURE 1.

The famous Gateway Arch in St. Louis, Missouri is the ultimate test of a person's fear of heights. This stainless steel arch rises 630 feet above the banks of the Mississippi and has a triangular cross section so that at the top of the span the walls slant outward at a 60° angle. The walls are made of glass and you can lie on them to see nothing but sky and the ground below you. The view is so spectacular and the sensation is so much like being airborne that I once spent almost an hour watching the miniature scenes below.

Obviously a hang glider pilot feels right at home at the summit of the arch, so that timely technique for dealing with high anxiety (don't look down!) is lost on us. However, how and where we direct our vision during the practice of our chosen mode of flight is very important for many reasons. In this article we will learn how to best use our sense of sight to enhance our flying ability.

From The Very First Step

Perhaps you have learned in your lessons how important a good run is to a safe, controlled takeoff. Airspeed allows control, and airspeed comes from your fleet feet during takeoff. Where you look is an important factor in how well you run. Your vision should be directed toward the ground about 10 feet in front of you. The terrain your feet are pounding should be at the bottom of your peripheral vision, while any bushes, weeds or the edge of a ramp that marks the end of your runway should be in the top of your peripheral vision.

The faster you run, the further ahead you should look. An exception to our first vision rule is when running on very uneven terrain (rocks, roots or bumps) and need a little more guidance as to where to place your feet. In this case you may have to watch the ground carefully. However, this is an advanced technique and should not be attempted by beginners. It is difficult to reach top speed when looking straight down.

Likewise, you will not show us your best sprint if you are staring up at the sky. Some pilots come out of their lessons with such a concern about their glider's nose position that they stare at it *while they are running*. This is quite a common bad habit. Have an observer watch you if you have any doubts as to where you direct your vision during your takeoff run. Learn to feel the proper glider position with your arms and watch the ground in front of you as you run.

High Flying

Your vision is your most overpowering sense. It can automatically control your muscles without consulting the brain. For example, you catch a fly ball in a mitt without taking the time to logically consider trajectories and other factors. You see it coming and snatch it without so much as a lost brain wave. So too can your sense of sight control your flying.

The first time you fly high you may be struck with a dramatic feeling of going nowhere fast. In your training flights you were close to the ground and your sense of vision was telling you how fast you were going by detecting the ground whizzing by. But your first step into the heights changes all that. Your immediate impression as the ground falls away is that you have no airspeed. Your hitherto trusty eyes confirm the matter so you pull in. If you are fairly high this accomplishes nothing as far as your vision is concerned, so you pull in more. This is such a common reaction that it has a name: *dive syndrome*.

The dangers of such a dive for an inexperienced pilot are the possibility of severe roll oscillations due to overcontrol, and not reaching the designated landing field as the result of excessive loss of altitude. Knowing that dive syndrome exists is the first step in preventing it. Before your first high flight remind yourself to judge airspeed by listening to the rush of air, feeling the wind on your face and especially noting your bar position. Again, it helps not to look down.

Avoiding Solids

The second example of how sight controls flight is known as *object fixation*. It has long been observed that people tend to steer in the direction they are looking. Many accidents on the highway have been caused by timid drivers fixating on the big semi passing them and actually steering right into it. The same thing takes place in aviation. There have been countless cases of pilots hitting the lone tree, rock or post in an otherwise huge field.

The mechanism at work here is object fixation; the pilot was so concerned about hitting the object, that he or she concentrated on it and flew right into it. How to avoid a similar fate in your personal flying? Simply *look where you want to go*, not at what you want to avoid. You may keep your dreaded obstruction in your peripheral vision, but by all means don't stare at it and you will avoid the embarrassment of tree magnetism.

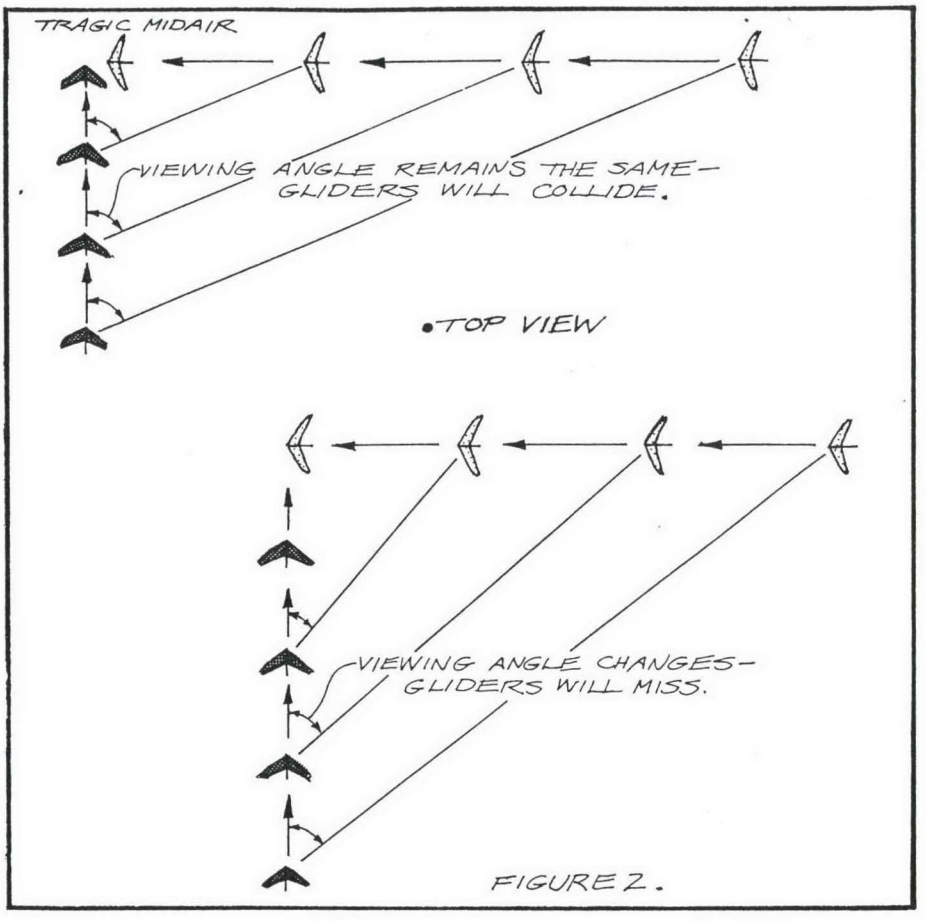


FIGURE 2.

Confusing Turns

Our next problem with vision in the realm of flight comes when you begin to perform continuous turns, otherwise known as 360's. In a coordinated turn the forces on your body are in balance, so your inner ear equilibrium system doesn't detect any motion. Yet your sense of sight is yelling "no way!" This conflict of sensory information can lead to a confusion in the brain that you feel as dizziness or *vertigo*. In its extreme form vertigo can result in complete confusion and loss of control.

I have witnessed pilots performing continuous, tight 360's and augering right into the ground as the result of vertigo. If this doesn't sound like fun here's how to avoid such a fate. First, begin doing gentle 360's one circuit at a time. The more continuous turning you do and the tighter the turn (the faster the turning rate) the more likely you are to suffer vertigo. Next, always look to the inside wing in a tight turn. One of the quickest ways to induce vertigo is to look to the outside of the turn, because the horizon is spinning by much faster.

Now the good news. You will build up tolerance to vertigo. That's why we use the gradual approach, adding additional 360's one at a time and tightening them only after lots of practice. As a personal example, I can perform

extremely tight continuous 360's and swing my head around at the same time without suffering vertigo. This is a result of years of practice.

Judging Traffic

The way your eyes judge the distance to a given object is mainly by relative size and relative motion against a background. In the air you don't have a lot of data with which to accurately tell how far a glider is from you, especially if it is at an odd angle and against the sky. Here we will point out a judgement problem and a solution.

The problem is called l*ooming*. This is a situation in which an object moving toward you at a uniform speed seems to grow in your field of vision very gradually, until it gets close to you and then it looms very large and may be unavoidable. This is shown in Figure 1. Looming is a phenomenon that has resulted in midair collisions in all of aviation. Be aware of its nature and take steps to avoid another glider long before it gets to the looming stage. With practice you will learn to judge clearance in the air very accurately, but for the time being, give yourself plenty of room.

Part of the problem of judging other air traffic is the mutual motion of your fellow pilots and you. This relative motion is always changing as well, due to airspeed and path changes. Thus, we rely on a simple visual rule to detect the possibility of midair collision: If the *viewing angle remains the same* between you and another glider, *you will collide* unless you take evasive action. If the *angle changes, you will not collide*. This concept is illustrated in Figure 2. We suggest that you practice this rule while driving your car by observing other drivers as they merge onto an expressway or approach from the side at an intersection.

Landing Judgement

The final aspect of vision in flight that we must investigate concerns judgement of landing setup. Again, a form of looming comes into the picture, for as we descend toward the ground the size of objects in the field seems to change very gradually until we get close, then the ground looms up to greet us rapidly. Misjudgment relating to this visual effect has often caused inexperienced pilots to make that one last turn that puts them too low.

Remember this: the eyes cannot judge height very readily. Don't bother to look straight down as you approach the earth since you are not acquiring much useful information. What you *can* judge is *angle*. In Figure 3 we illustrate a way to judge proper positioning from a field and the proper height to turn on final by viewing the angle from the horizon to your chosen landing spot. Whether you use a downwind-base-final or a figure-8 approach, you must use this angle method to be an accurate lander. Landing setups are too complex to cover completely here, so we recommend the chapters devoted to the subject in H*ang Gliding Flying Skills.*

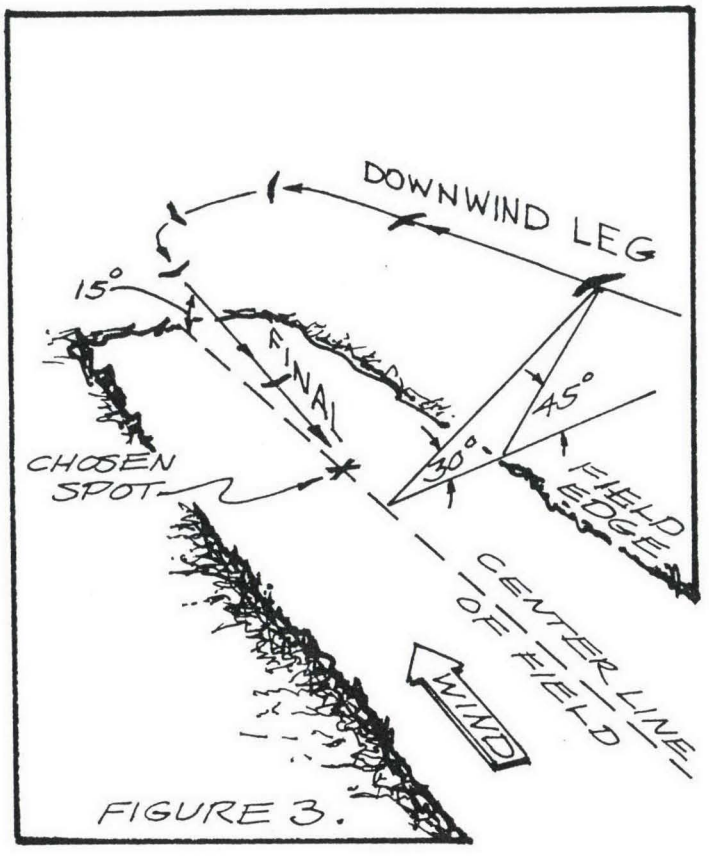


FIGURE 3.

Your sense of vision is of primary importance in the air. Close your eyes for a moment while in flight (out of traffic, please) and you'll be convinced. However, it can get an inflated view of its own importance, so to speak, and often takes over command from the brain. We need to be aware of this tendency in our personal guidance system and prevent misperception from overwhelming our good sense.

The limits of vision and judgement are well known to experienced aeronauts. Learn the simple rules and tricks we have covered here and your prospects in flight will definitely not be looking down, but decidedly up. ■

Learning To Land

With a little practice you can consistently land safely and gracefully.

article and photos by Paul Voight

Excellent approach form.

Introduction

Landing a hang glider is an art. Of all the skills at which you will need to become proficient, landing is one that will continuously challenge you throughout your flying career. Consistent, powder puff, no-step landings are the elusive goal of all hang glider pilots. Just spend a couple of hours at your local landing zone and you'll see many of the possible "variations on a theme!"

However, I'm here to tell you that with a little practice you can consistently land safely and gracefully. It is also very easy to avoid injury on your journey toward perfection. There's no need to be scared... just wary.

Each landing is unique, and requires your full attention until you have come to a complete stop. Unlike powered aircraft pilots, you only get one go at it. You can choose your flying conditions, your launch cycle, and fly your own flight plan, but once the ground comes up you have only those conditions, at that moment, to deal with. Nevertheless, this is actually one of the most fun aspects of flying hang gliders. Nothing is more satisfying than executing an elegant landing (preferably near the bull's-eye), to ice the cake after a flight.

Since you are reading this article in the New Pilot Edition of *Hang Gliding* magazine, I'm going to assume that you are either a brand new or prospective pilot. Perhaps you've just finished your first training hill lessons, or experienced a tandem flight with a tandem instructor. With this in mind, this article will first address how you should approach the whole concept of landing, and then touch specifically on the "how to" aspects of landing.

Notice loose grip by pilot even on a tandem landing.

"At an altitude above ground effect, rock upright, with a loose grip *on the downtubes, locating your hands about two feet below the apex of your control bar at about shoulder height. Once in ground effect, slowly allow the glider to slow down to trim speed. Now you wait until you just sense the glider beginning to settle (stall) and push out the appropriate amount for the given wind condition at that instant. That's all there is to it."*

Wheels

For starters, I think wheels are good. No one flies without them in my school. There have been schools which have succeeded without wheels, but the idea gives me gray hair. The way I see it, wheels can't hurt. Besides the obvious safety benefit, they can save you lots of money (fewer abrupt stops, fewer broken downtubes). You definitely don't want to become reliant on them or you won't learn to land, but it sure is nice when they're there if the basetube contacts the ground before you do!

Practice, Practice, Practice

Next, here's the best advice I can give you. Practice a lot, and more importantly, practice frequently. This will help all of your hang gliding skills, more so than any reading or verbal instruction. It is my belief that you learn hang gliding by doing it; it's not a sport you should consider if you only wish to dabble in it. A common scenario I see in the business involves students who allow months to pass between outings. They are always coming back from a long layoff. They are nervous. They haven't retained what little they learned on their last lesson. Their landings, as a result, are often "less than perfect." This is neither fun nor productive for the student or the instructor. By flying regularly, progress comes quickly. Good habits are reinforced. Bad ones are isolated and eliminated. Your flying becomes more and more instinctive, and less and less laborious.

Learning to drive a car is very similar to learning to fly. In the beginning you grip the steering wheel much too tightly. Your input is overly deliberate; you have to think about everything. But after you've accumulated some "hours," you are able to sail along, with a light grip on the wheel, casually making the necessary corrections almost without thinking. Believe it or not, flying will get this way for you as long as you get out often enough to achieve the desired skill level.

Assuming you pursue your flying regularly, your landing career will probably take one of two roads. A few pilots simply grasp the concept early, have a natural affinity for it, or have been good all their lives and benefit from the resulting karma. The majority, however, need to work through a variety of subtle technique refinements before any consistency is realized. Generally though, once a string of great landings is achieved the battle is won. Some pilots take longer to achieve that hot streak than others, but you'll get there at your own pace if you stick with it.

The Right Glider

The selection of your first glider will have a great deal to do with your success rate. It's not that you can't succeed in learning to land a glider that's too advanced for you, it will just take a lot longer, cost more, and provide you with some unnecessary, unnerving moments.

There is such a selection of great performing, easy landing, entry-level gliders on the market today that there really is no reason to put yourself through the "advanced glider" syndrome. Besides, entry-level gliders retain their resale value since there are always new pilots looking for nifty used gliders.

So, with proper instruction, frequent practice, and a glider suitable for your level of skill, your landing career should be off to a good start.

No wind landing — full flare, feet back.

How To

As promised, we'll get to the "how-to" department. On paper it's simple. Here's how you *should* be able to pull off perfect landings every time.

First, plan your approach. Watch the wind sock, and read other indicators (smoke, water, grass, etc.). If you are still on the training hill, be selective about your launch cycle, since it will probably double as your landing cycle. Line things up so that the last 30 seconds of your flight are spent flying directly into the wind, carrying a little extra speed. At an altitude above ground effect, rock upright, with a *loose grip* on the downtubes, locating your hands about two feet below the apex of your control bar at about shoulder height. Once in ground effect, slowly allow the glider to slow down to trim speed. Now you wait until you just sense the glider beginning to settle (stall) and push out the appropriate amount for the given wind condition at that instant. That's all there is to it. It should put you right on your feet. Obviously, it is easier said than done, and I will point out some of the variables and scenarios that lurk to thwart the perfect landing.

Starting with the approach, right on through to final flare, remember that the wind can (and will) change in both velocity and direction (with the possible exception of beach sites). You have to be very alert to these changes, and make corrections as needed to enable you to land as much into the wind as possible. It is NOT, however, absolutely critical to land squarely into the wind. You would prefer it, but may possibly fair worse executing a low turn (risking a flare while banked or a touched wing tip) than simply landing in a slight crosswind.

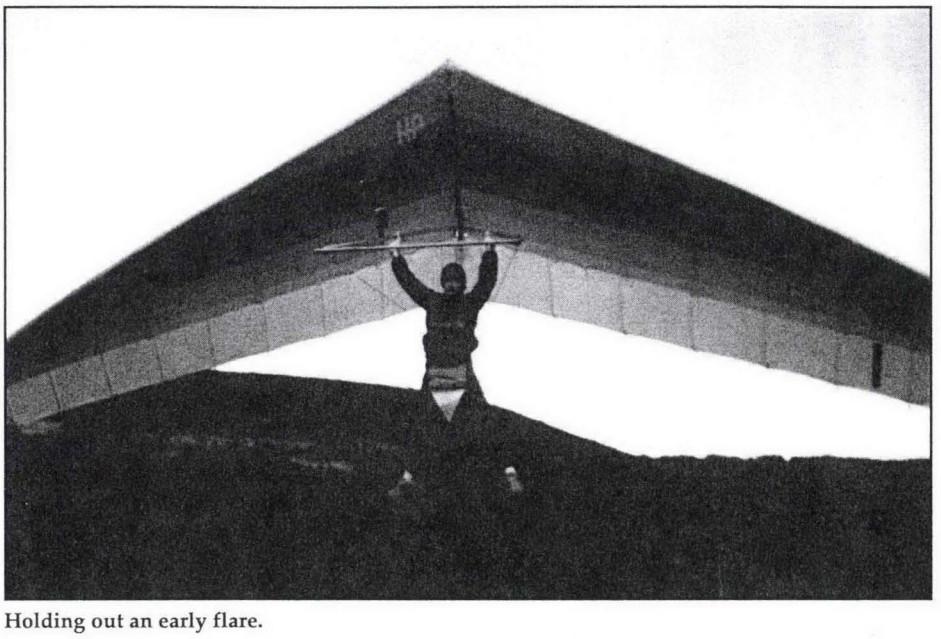
As an additional note on approaches, I recommend sticking with the same style of approach (S-turns or aircraft) for each of your flights. This leaves only the conditions as the variable, and not your technique.

There is almost always some amount of gradient (less wind near the ground) and surface turbulence as you approach the earth, so extra speed is called for to get you through this layer of air. Floating your landings in is generally an invitation to disaster. Speed not only gets you through this air more quickly, but affords you quicker and easier handling.

Another common problem is pilots slowing down (allowing themselves to be slowed down) in gusts, so that once the gust is behind them, they are left with little airspeed and a high angle of attack. (Drum roll...WHACK!) Again, keep your speed up and things should go much better, even in gusty air.

When to go upright is an ongoing debate. I feel that you should do it early enough so that, should the act of rocking upright cause either a turn or a speed change, you'll have time to correct the problem before impact. In addition, it is a fact that pilots weather crashes much better upright than in the prone position. Head first just isn't the way to hit the ground.

In the event of a mistimed flare (the real nemesis of perfect landings), you still have the ability to salvage the landing with the correct reactions. If you've flared early and climbed up higher than you'd like, you need to override your desire to pull in and hold the nose up instead, with all you've got, while keeping your feet back. This will, with some luck, result in a very nice parachuting descent onto your feet. You will certainly do worse by pulling in. A stalled, stopped glider won't start flying again.



Holding out an early flare.

If you've flared late (a less nerve-wracking mistake), hold the nose up again, and run the landing out. (This is where wheels can be your friend!)

How much to flare? It is very common to see pilots flaring the same amount in all conditions, which is wrong. In a no-wind situation (typically the most difficult condition in which to land), you'll need to flare quickly, aggressively and completely. In a windy situation you need to flare slowly, and only enough to stop your forward motion across the ground. There is no need to land going backwards. Most landings require some compromise between these two extremes, and learning how aggressively and how much to flare comes only with experience.

My last suggestion is to choose situations which offer landing conditions commensurate with your skill level. This is one area in hang gliding where you do not need to seek challenging conditions; they will find you. You can expect the worst, most inconsistent air in the middle of a sunny day since the wind is greatly affected by thermal activity. Also, as a general rule, the higher the wind velocity the more "texture" there is to the air. What you're looking for to get a handle on landings are relatively smooth conditiöñs found in the morning and late afternoon. Once you are consistent in these conditions, you may opt to land in those more challenging conditions.

I hope this article gives you enough information to develop a landing technique that works for you. I'll leave you with a short list/recap of the major hints for landing proficiency, and wish you a long streak of perfect touchdowns.

1) Use equipment suitable for developing basic skills.
2) Practice regularly.
3) Relax while landing. A loose grip is key to good landings.
4) Do not use groundspeed as a reference. Airspeed is what counts.
5) Start your approaches while still high. Plan ahead.
6) Use the same style of approach as often as possible.
7) Be flexible, correcting for changes in the wind.
8) Flare only enough for the wind conditions on landing, keeping feet back.
9) If you flare early, hold it out.
10) It is not mandatory to land directly into the wind.
11) Keep extra speed below 100 feet. This isn't the time to stretch your flight. ■

Paul Voight is a Master-rated pilot who has been teaching hang gliding since 1979. He is owner/operator of Fly High Hang Gliding, a full-service shop two hours north of New York City. He is currently Vice President of the USHGA.

Hang Gliding Instruction Reaches New Heights

by Greg DeWolf

You've played that game when you were a kid, where a group of people sit in a circle. One whispers a simple sentence to the next, and it's passed around in similar fashion until it returns to the beginning. When the phrase is finally vocalized, all erupt in laughter, since it's usually absurd and bears no resemblance to the original statement. The lesson learned is how differently individuals interpret, remember and then express what they've heard.

Even though hang gliding instruction seldom passes from more than the instructor's mouth to the student's ear, the amount of information that's passed creates the probability that the student will misunderstand some details. Instructors also make control movements and decisions of which they are not consciously aware, so one can begin to understand the important role experience plays in the learning process.

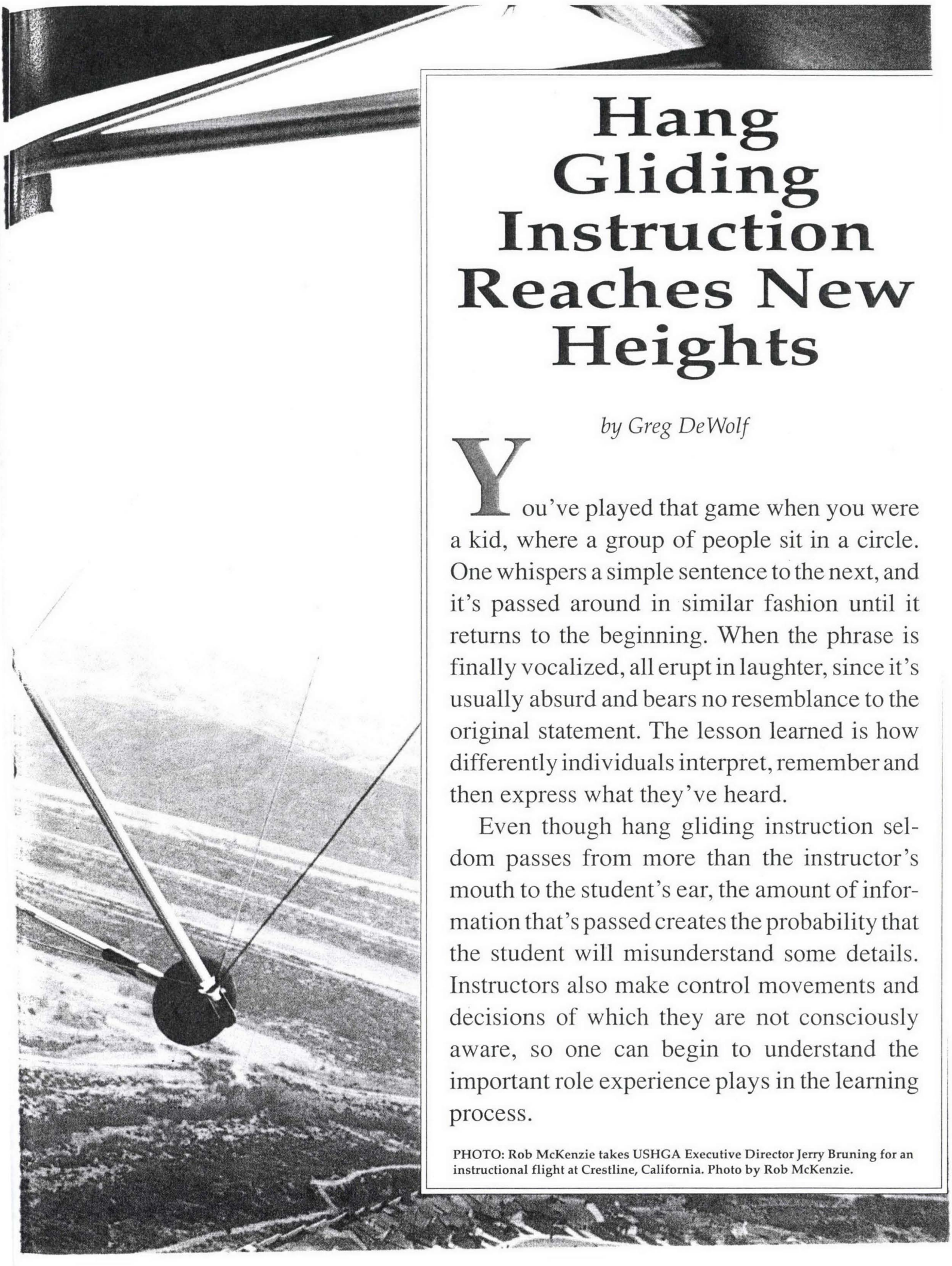
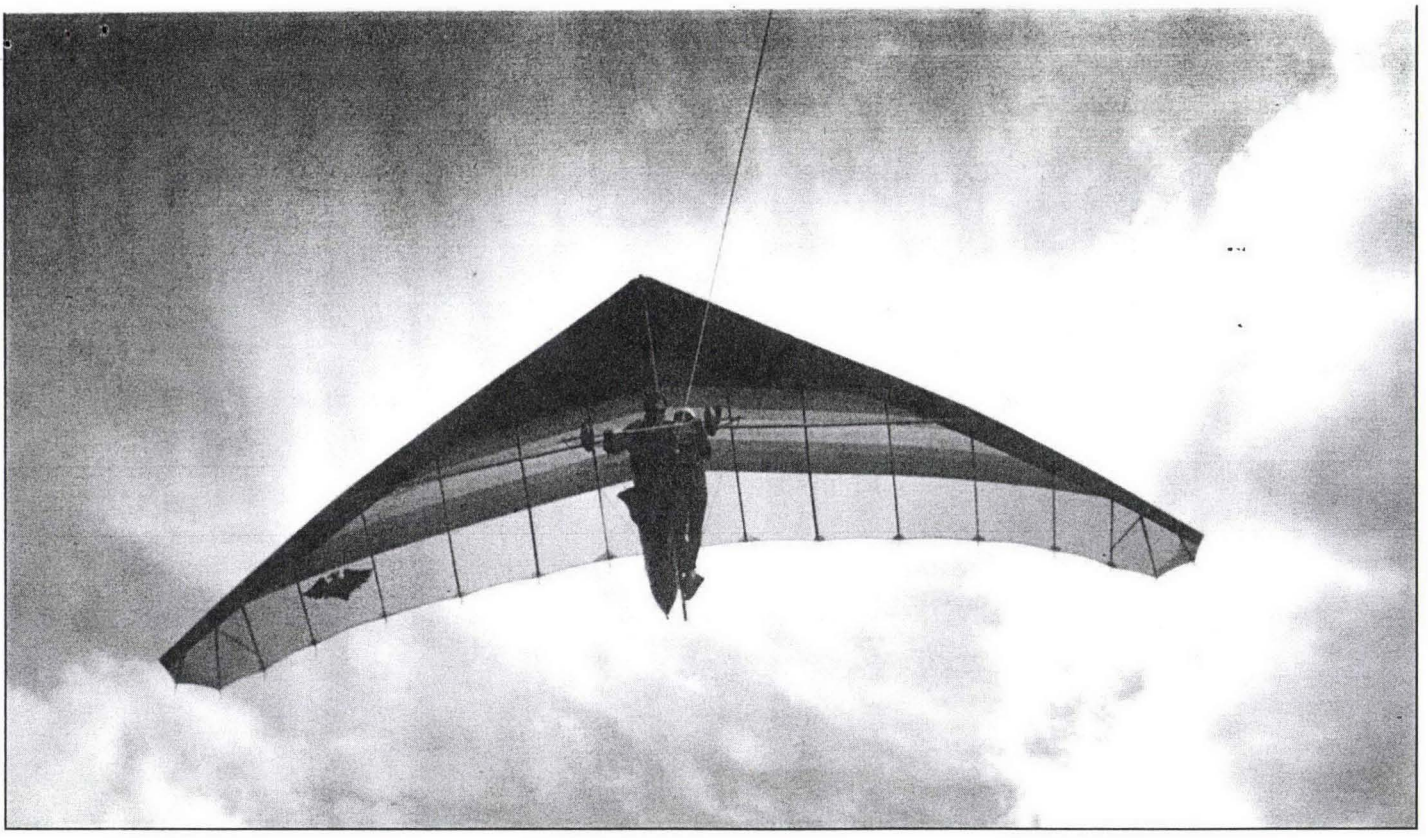


PHOTO: Rob McKenzie takes USHGA Executive Director Jerry Bruning for an instructional flight at Crestline, California. Photo by Rob McKenzie.



Experience Through Trial And Error

Trial and error is an effective learning method and ultimately must be employed in learning any skill. In windsurfing or horseshoes any number of errors may be compounded without serious consequences, but flying is not so forgiving. One blunder gets the adrenaline flowing, two combined mistakes necessitate a change of undergarments, and three simultaneous errors can lead to injury.

This is why solo hang gliding is taught close to the ground, so that the first mistake returns you to earth before you can compound it with additional errors. When you realize that there are no "time outs" in which to reflect or compose yourself while faced with difficult decisions, you begin to understand the need to accumulate flying experience in a more controlled environment.

History Of Flight Instruction

The problems of teaching solo flight were discovered early in history when Icarus became so enraptured with altitude that he forgot, or disregarded, the instructions of his father Daedalus—to stay low, away from the heat of the sun. The wax melted, his feathers fell out and he paid for his impertinence with his life.

Things didn't change much over the next 3,500 years. Instructors explain the intricacies of flight, accompanied by much arm waving, but when the student climbs into the aircraft, he flies alone. The problem arises when the student, who was doing fine skimming the ground (where few options are available), is elevated to a more lofty position, where his options explode and his entire perception of the world and environment changes.

Dual flight—or "tandem" as it's called in hang gliding—came to the sport early on, but was used mostly for the purpose of impressing and thrilling members of the opposite sex. Passengers were those who never cared to fly alone, but who wanted the experience. Anyone who was serious about flying learned solo.

In the early 1980's a couple of instructors, including Rob McKenzie of High Adventure, realized the benefit of tandem instruction. An instructor could save a lot of arm waving by giving the experience to his student first hand, while next to him on the glider. The problem with tandem instruction was its lack of efficiency. It's difficult for one instructor to make more than two or three tandem flights a day from a mountain.

The Process

Learning to fly is eventually more a process of learning *how to learn* than it is of learning facts. Theories can be not only difficult to comprehend, but the pilot may be too preoccupied to apply them in flight. A student must experience some trial and error, and the safest way to do this is with an instructor on board to limit mistakes and help the student when problems arise.

The advent of Jerry Forburger's Air Time of Lubbock Truck Towing System not only improved the safety of towing by an order of magnitude, but made tandem towing feasible for the first time. Ten to 20 flights a day could be accomplished, giving five or six students three or four high flights each. Tandem instruction began to develop into an acceptable teaching method. All it took to get started was the development of the right equipment and techniques.

A Close Student-Instructor Relationship

The benefits of tandem instruction are many. One of the greatest is the student's ability to watch and feel the instructor fly; being in the glider while maneuvers are performed correctly, a student can learn what it's supposed to "feel" like.

> Example: While undergoing instruction with a radio on my helmet and my instructor Joe on the ground, I was told to perform a snap turn. Joe had described the procedure before the flight: "Pull in hard, shift your weight fully to one side, when the glider is banked 60° push out hard, carve a 180° arc, then pull in and center your body." But now with 2,000

(Continued on page 53)

Dual Instruction
Pros & Cons

by Rob McKenzie

Even though general aviation embraces dual instruction for flight training purposes, hang gliding dual instruction is limited in the U.S. But where found it is generally considered a terrific tool to teach novice and intermediate skills. Some inherent differences between hang gliding and general aviation account for the limited use of dual hang gliding instruction.

Dual hang gliding training has many advantages over the progressively-higher-hill solo method of training. Your instructor has a better ability to determine your fear level, and can use this to evaluate your chances of handling high altitude solo flight. You can practice the basics of flight control, approach skills, right-of-way rules and soaring skills in a controlled situation that benefits from the safety that is directly related to your instructor's experience.

Over the years I've seen students learn skills in a few days that used to take months using the old method of progressing with solo flight from the 20' hill up to the 300' level. Mountain sites like Crestline in California have lowered the site rating from intermediate to a qualified novice to accommodate students who were dual trained. It has been found by several schools in Southern California that with as few as five dual flights totaling about two hours of airtime, the average Beginner-rated pilot can progress to solo flight from mountains of several thousand feet.

Dual instruction is not limited to foot-launched flight. Both truck tow and aero tow flight benefit from dual instruction, perhaps even more so than foot-launched flight. Tow launches are an all-or-nothing proposition. In foot launch a student can jog down low, shallow slopes and make a partial flight by doing the landing flare just as the glider begins to lift him into the air. It can be described as the first half of the launch and the last half of the landing all rolled into one. The same is not possible with tow launches. One cannot half-launch from the back of a truck or be half-connected to an aero-tug. This inability to gradually work up to launch procedure makes dual instruction for towed flight very valuable both for students and experienced foot-launch pilots learning to tow.

As mentioned earlier, there are reasons why dual instruction will never be the universal training tool in hang gliding, as it is in general aviation. In general aviation students solo in the same aircraft in which they do their dual training, and there is only a subtle difference in feel when flying solo as compared to when the instructor is on board. In hang gliding, special large gliders are used for dual training, and the student usually solos in a different glider that is smaller and has different handling characteristics than the dual machine. Students can prepare for the differences through discussion with the instructor about what to expect prior to the first solo, and by thorough bunny slope practice on the solo glider.

Landing a hang glider is generally considered tougher than landing most airplanes or sailplanes. Landing a hang glider while flying dual, especially in no wind, is even tougher. Only a small percentage of hang glider pilots will ever develop the ability to do consistently safe dual landings, and only a fraction of these will want to enter the field of hang gliding instruction. The result of all this is that there are currently only a handful of active, good, dual instructors in the U.S.

A dual flight does not guarantee an effective lesson. Instructors have vastly different abilities. If you are looking for a good dual instructor find one who will let you do the flying and not constantly ride the controls. You should find an instructor who tries to maximize the time that you are at the controls. In the ideal situation your instructor will require that you do everything, including assembly, preflight, flight plan, launch, approach, landing and teardown. The instructor should merely ride along, observe and add comments as needed.

The final disadvantage of dual instruction is one of economics. A large school with high overhead that teaches foot-launch hang gliding might not use dual instruction even if a good dual instructor and site are available. Hiring one instructor to teach six students at a time makes better sense than two employees (pilot and driver) to teach one lesson at a time. This economic disadvantage of dual instruction often means that the large schools either don't offer it, minimize its use or charge more for it than the lower-overhead smaller schools can afford to charge.

The bottom line is that if you can find good, local, affordable dual instruction take advantage of it, but don't be surprised if it's hard to find or expensive. ■

Rob McKenzie is a USHGA Tandem Instructor who has logged more than 4,000 dual instructional flights since 1980, and is the main instructor for High Adventure in San Bernardino, California.

feet of air under me, the instructions swam around in my head, defying a solid mental grip.

Being the weenie I am, I pulled in a little, shifted my weight a little and pushed out a little. Feeling the "G" forces build reminded me that I'm stronger than the average guy, my arms are much longer, and I always go to extremes. Since I was afraid of breaking the glider, it took me another year before I correctly learned this important maneuver.

More Reasons To Take Tandem Instruction

The tandem learning process proceeds more expediently as the result of many factors. The one-on-one instructor-student relationship gives you the instructor's undivided attention. During a tandem lesson you can concentrate more information and practice into two hours alone with the instructor, amassing half an hour or more airtime.

Student pilots aspire to great heights in hang gliding, and tandem allows that experience from the first flight. The instructor can catch the student on his first mistake, preventing additional complications and giving immediate feedback.

The time and energy spent carrying the glider from the landing area back to the top of the hill can be eliminated. This is replaced with flying and relaxed communication between you and the instructor.

Launching and landing are the most difficult phases of flight. With tandem instruction you can learn other flying skills first, then progress to the more difficult launching and landing skills.

Two Relaxed

Tandem hang gliding instruction is accomplished like dual instruction in general aviation. The instructor is right by your side, and handles the launch and climb to safe altitude while you observe his technique. You are then given control of the aircraft, while far from danger, and introduced to the control movements and reactions, one by one, in a leisurely manner.

You can focus attention on one skill at a time, experiment and even make mistakes, since the instructor is by your side to explain and take over if necessary. You spend half an hour or more during each lesson where you want to be, in the air learning how to control the glider and experiencing flight. Feedback from your instructor is immediate, and he has intimate knowledge of how you and the glider are flying. Your landings are graceful, allowing you to pay attention to technique and form right from the beginning.

By the time you're ready to solo on a high flight you have six to twelve hours of altitude experience, the average first-year airtime of a solo-instructed student. But you are more than a year ahead, for your instructor has already taught you skills that would have taken three or four years to learn on your own.

List To Learn

Just as in general aviation, hang gliding instructors come in all degrees of ability and preparedness. Unlike general aviation, there is no standard syllabus of skills for the instructor to teach. So here I list, with a short description, the maneuvers I teach my students.

Straight Flight — Flying the glider in smooth air on a heading, making small corrections without "hunting" or weaving.

Gentle Turns — 10°-20° bank with correct, constant airspeed.

Three Methods of Lateral Weight Shift — The jab, the slide and the leg lead.

Pitch Control — Bar position, bar pressure and airspeed methods.

Clearing Turns — Where to focus attention and how to acknowledge other pilots in the air.

Stalls and Mushes — How to notice and correct these conditions.

Fast Flight — The feel, control problems and uses of high speed flight.

Upright Control — The feel, control problems and three techniques of flying in a standing, landing position.

Stalled and Slipping Turns — The techniques, feel, usage and dangers of entering and exiting.

Three Types of Landing Approaches — Aircraft, "S" and 360°.

Glide Recognition and Control — Methods for determining and affecting glide angle in various conditions.

Flare Timing and Technique — Demonstrate the relationship between timing, extent and speed of the landing flare and three combinations that work in different situations.

Towing Techniques — Not just how to do it right, but demonstrate what and how things go wrong and methods that work and don't work in correcting those problems.

Speeds to Fly — Proper speeds to fly in various micrometeorological conditions as well as correct speeds for various maneuvers.

Dealing With Turbulence — Methods of glider control in turbulent air.

Altitude Recognition — How to judge altitude without instruments.

Ground Wind Speed and Direction Recognition — How to tell wind conditions on the ground while still high enough to do something about it.

Emergency Procedures — Dealing with situations where you have little altitude or time to make decisions.

Selecting An Instructor

Choosing the right tandem instructor is of paramount importance. You will not only be following his instructions, but will be by his side, your life literally in his hands while he flies. How can you judge?

USHGA Tandem Instructor certification is a must, though it is no guarantee. The only pilots who can legally charge for instruction are USHGA rated. Ask to see a current, laminated USHGA rating card with "Tand/Adv. Instructor" typed next to "Ratings:" near the bottom of the card.

Training flights of at least 10-15 minutes duration. Although shorter flights can be useful and are necessary for teaching landing approaches and emergency procedures, little else can be taught on flights under 1,500 feet.

Tandem experience of five years and 1,000 flights or more is very desirable. Tandem instruction is still mostly a self-taught skill, and the less-experienced instructors are still learning though trial and error.

Consistency of location is an indication of stability and maturity. Most of the best tandem instructors have been working in the same place for five to ten years.

Student Brad Stevens practices clearing coordinated turns with feedback from instructor Greg DeWolf. Instructor's position keeps him out of the student's way.

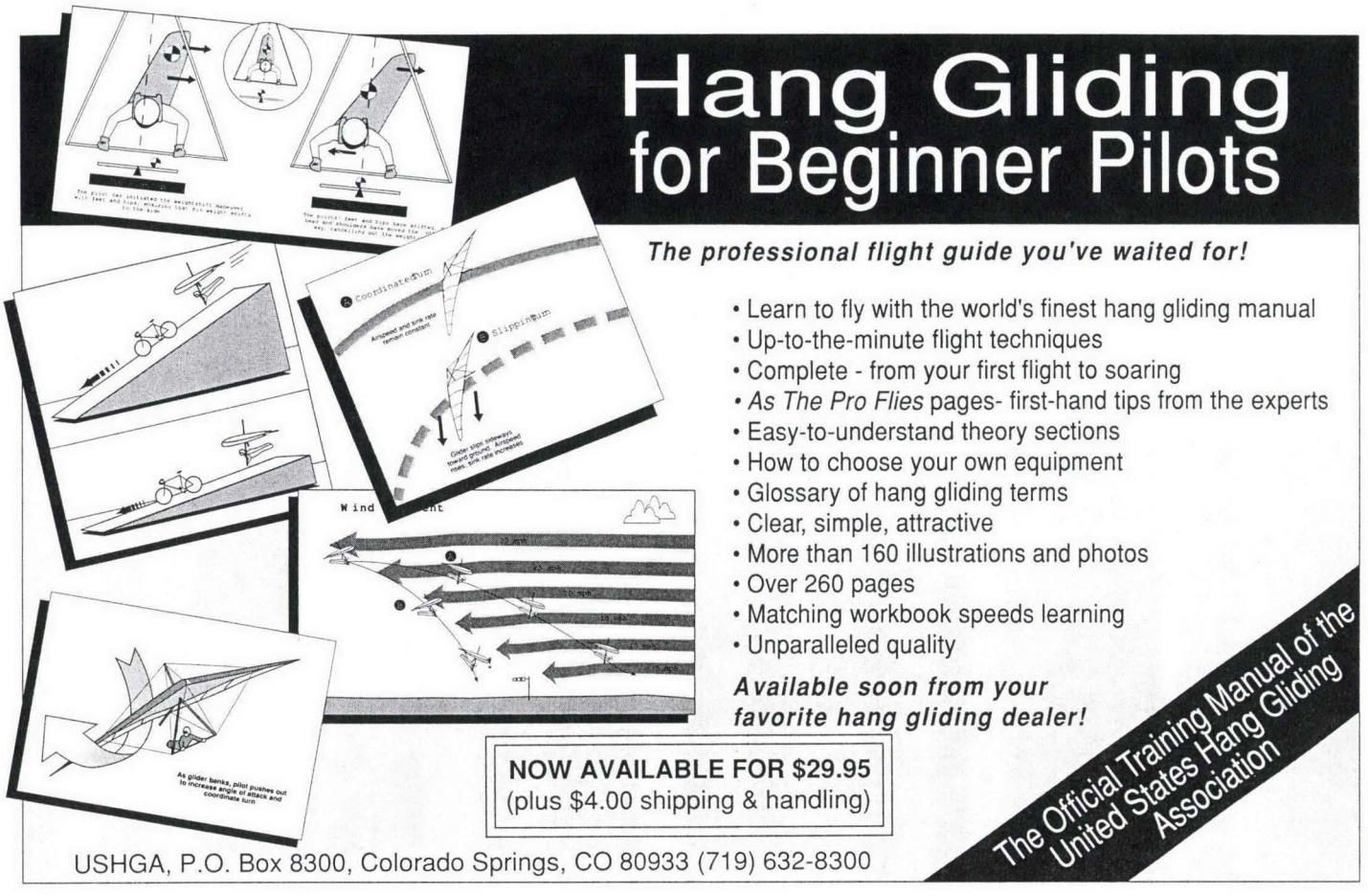
One- or two-step landings demonstrate that the pilot at least knows how to perform the most difficult of all flying skills. The pilot who lands like a bird, with his nose high and consistently in the same spot, usually has a good grip on his other flying skills.

Inspect the equipment. The condition of an instructor's equipment is often a clue to his flying and teaching style.

Watch the instructor's students fly. Although skills are student dependent, attitude and safety reflect on the instructor.

When you fly, your instructor should be able to explain calmly and thoroughly what he wants from you and how you should accomplish the maneuver. He should be able to control the glider in a smooth and relaxed fashion, and should introduce you to how and what things go wrong as well as correct flying technique. ■

Greg DeWolf has been flying for 14 years and is a Master-rated pilot with 3,184 logged tandem flights. He is an Advanced Instructor, Tandem Instructor and Tandem Administrator. In 1988 he led Fly America across the United States. His school, Corolla Flight, is located on the Outer Banks of North Carolina, 20 miles north of Kitty Hawk.



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A Hang Gliding Glossary

Aerodynamics—The study of the movement of a body, such as a hang glider wing, through the air.
Aerodynamic Controls—Moveable surfaces used to control a glider. These consist of elevators, elevons, rudders, spoilers and ailerons. Flex-wing hang gliders usually do not have aerodynamic controls. Rigid wings usually do.
AGL—Above Ground Level. Altitude above the ground.
Airfoil—A curved surface designed to generate lift when moving through the air.
Airspeed—The velocity of a glider through the air. This is not necessarily the speed of the glider over the ground.
Attitude—The amount of nose-up or nose-down relative to the horizon.
Angle Of Attack—The angle the relative wind makes with the chord of an airfoil.
AN Part—Any piece of hardware certified for use in an aircraft.
Aspect Ratio—Ratio of the span to the chord, or span^2 divided by wing area. Higher aspect ratio usually means less induced drag.
Bank Angle—The angle the wings make with the horizontal in roll.
Battens—Stiff shafts inserted in the sail to hold shape.
Beak It—To nose in on landing.
Blue Thermals—Thermals that don't produce clouds due to low moisture content.
Camber—The amount of curvature on the upper surface of an airfoil.
Carabiner—An oval ring used to attach the harness to the hang loop.
Center Of Gravity (CG)—The point along the keel where the pilot's weight is suspended.
Center Of Pressure (CP)—The point along the keel where the resultant of the lift and drag is considered to be acting.
Chord—Measurement of an airfoil from the leading edge to the trailing edge.
Control Bar—A triangular set of three tubes used for support and control.
Coordinated Turn—A steady-state turn in which a slip, skid or stall does not occur.
Cross Bar—A spar running perpendicular to the keel which holds the leading edges in place.
Cross-Country (X-C)—A distance flight in a hang glider. The current record is 287 miles.
Damping—Tendency of a glider to resist motion in a particular direction. Damping in pitch is the tendency to resist a change in angle of attack.
Defined Tip—A device holding up the rear of the sail at the wing tip to provide dive recovery.
Dihedral—An upward angling of the wings from side to side. Used to create roll stability.
Divergence—Tendency of a glider to enter an ever-steepening dive when flying fast.
Downtube—One of the uprights of a control bar.
Downwind—Flying in the direction the wind is blowing (flying with a tailwind).
Drag—The energy losses of a glider due to the friction of the air or as a by-product of the production of lift (parasitic and induced drag, respectively).
Fairing—A streamlining device used to reduce parasitic drag.
Glide Angle—The angle between the glide path and the horizontal.
Gliding—Unpowered flight that continues from an elevated point to a lower point.
Glide Path—The flight path of a glider.
Glider—An unpowered, heavier-than-air aircraft.
Glide Ratio—The ratio of the distance traveled forward to the distance dropped by a glider. One of the main measures of glider performance. In calm air this is equivalent to the lift to drag ratio of the aircraft (L/D).
Ground Effect—An improvement in glide caused by proximity to the ground.
Ground Speed—The velocity of a glider over the ground. If any wind is present air speed and ground speed will be different.
Hang Loop—A loop of webbing or rope used to attach the harness to the glider.
Harness—A suspension system that supports the pilot and attaches him to the glider.
Heading—The direction a glider points in flight (different from actual flight direction in a crosswind).
HGMA—Hang Glider Manufacturers Association.
Keel—The spar running fore and aft in the center of a glider.
Kingpost—The upright tube on top of a glider used to support the wing when not in flight. Also supports reflex bridles.
Knee Hangers—Harness lines running from the shoulders to the back of the legs, which hold the legs up while flying prone.
Leading Edge—The forward-most part of a wing. The spar that forms this forward part.
Lift—Rising air used by a glider pilot to soar. The upward force creating by a wing.
Lift To Drag Ratio (L/D)—A comparison between the lift forces and drag forces created by a wing. An important measure of performance, which determines how far a glider can fly with a given amount of altitude in calm air.
LZ—Landing Zone.
Max Glide—The best possible glide ratio for a given pilot/glider combination.
Min Sink—The best possible sink rate for a given pilot/glider combination.
MSL—Mean Sea Level. Altitude above sea level.
Nose Angle—The angle between the leading edges.
Nose-In—An accident in which the pilot lets the nose of the glider get too low on takeoff or landing so that it hits the ground.
Nose Plate—The plate holding the leading edges and keel together at the nose of the glider.
Pitch—Amount of nose up or nose down.
Reflex—An upward bending of the rear of an airfoil which creates pitch stability.
Reflex Bridle—A line from the kingpost to the rear of the sail which creates reflex in a dive.
Relative Wind—The apparent wind as the glider is flying. Since the glider is always falling with respect to the air around it the relative wind is different from the actual wind.
Ridge Lift—Rising air which results from wind being deflected over a hill.
Roll—Lifting or dropping of a wing from side to side.
Root—The center of a wing. The keel area on a hang glider.
Rotor—An organized swirl of air behind a cliff face, hill, mountain, building or row of trees. Rotor turbulence is often considered to be the most dangerous kind.
Sink—Falling air which makes a glider lose altitude faster than normal.
Sink Rate—The speed with which a glider descends vertically through calm air. Usually expressed in feet per minute (fpm).
Skid—Sliding toward the outside of a turn.
Slip—Falling to the inside of a turn.
Soaring—Extended flight achieved by finding and staying in rising air.
Span—The total width of a glider from tip to tip.
Stability—Tendency of a glider to return to straight and level flight when upset.
Stall—A loss of lift, usually caused by flying too slowly.
Sweep—The angling back of a wing in a planform view.
Tailwind—A wind from the rear or in the direction of flight.
Thermal—A mass of warm rising air which provides lift.
Trailing Edge—The rearward part of a wing.
Turbulence—Gusts or swirls of air that may make it hard to control a glider.
Upwind—Flight heading into the wind.
USHGA—United States Hang Gliding Association.
Variable Geometry (VG)—A system which allows a hang glider to change shape (and therefore flight characteristics) by moving the cross bar.
Variometer (Vario)—A device which tells a pilot whether his glider is rising or falling relative to the ground.
Washout—A twist in the wings yielding a gradual lowering of the angle of attack from the keel to the wing tip. Helps create pitch stability in a swept wing.
Wind Gradient—Slowing of the wind as the ground is approached.
Wing Loading—The weight-to-area ratio found by dividing the weight of the pilot and glider by the wing area. Usually measured in pounds per square foot.
Wuffo—Someone who doesn't know anything about hang gliding. A bad hang glider pilot.

Adapted from a hang gliding glossary by Dennis Pagen of Sport Aviation Publications

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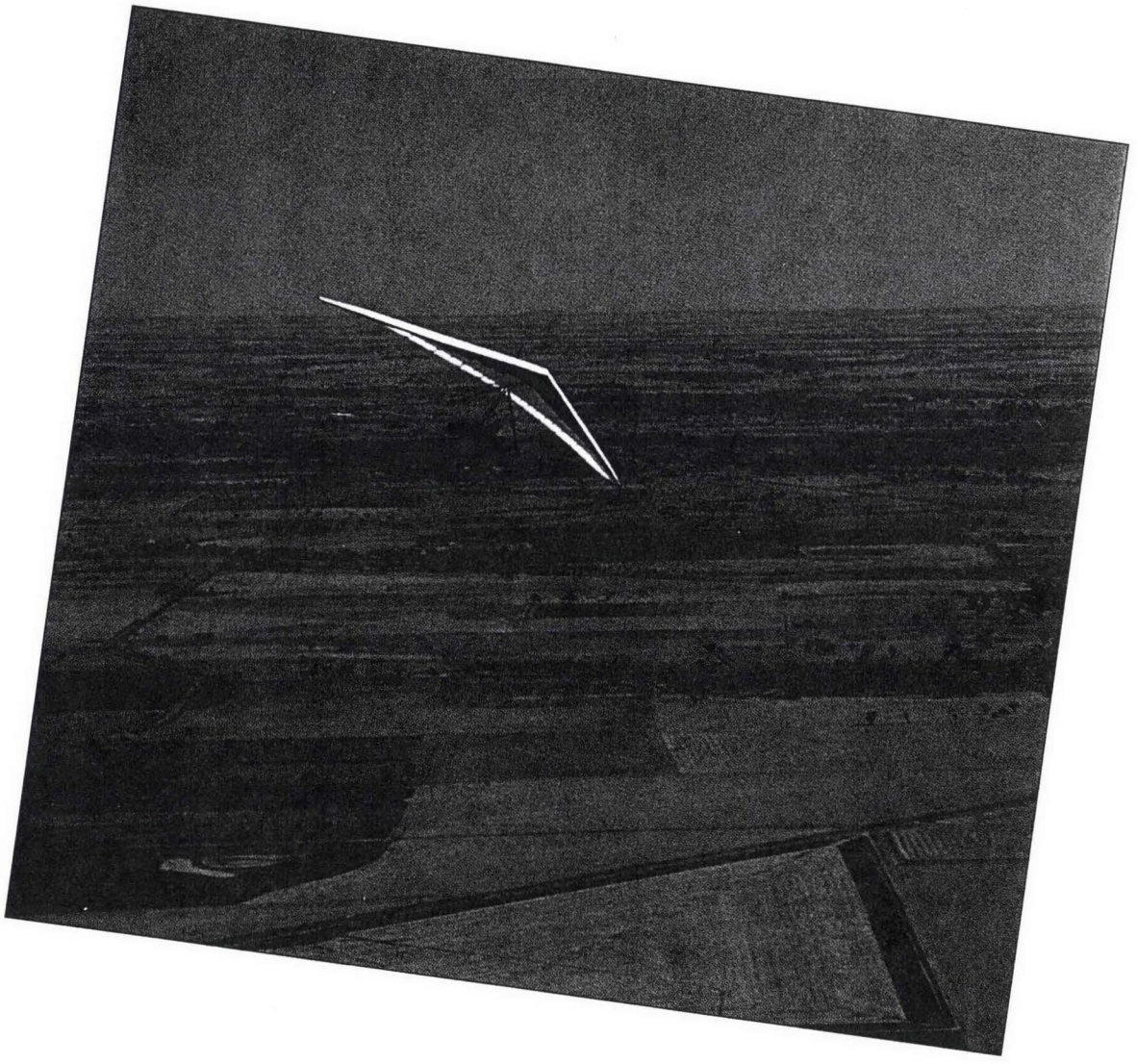

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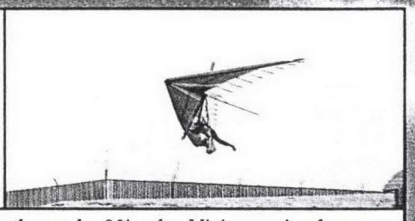

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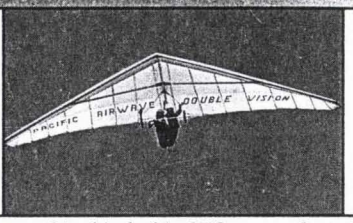

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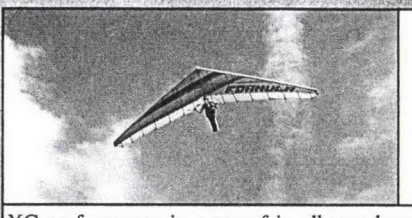

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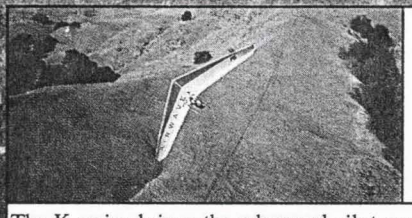

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