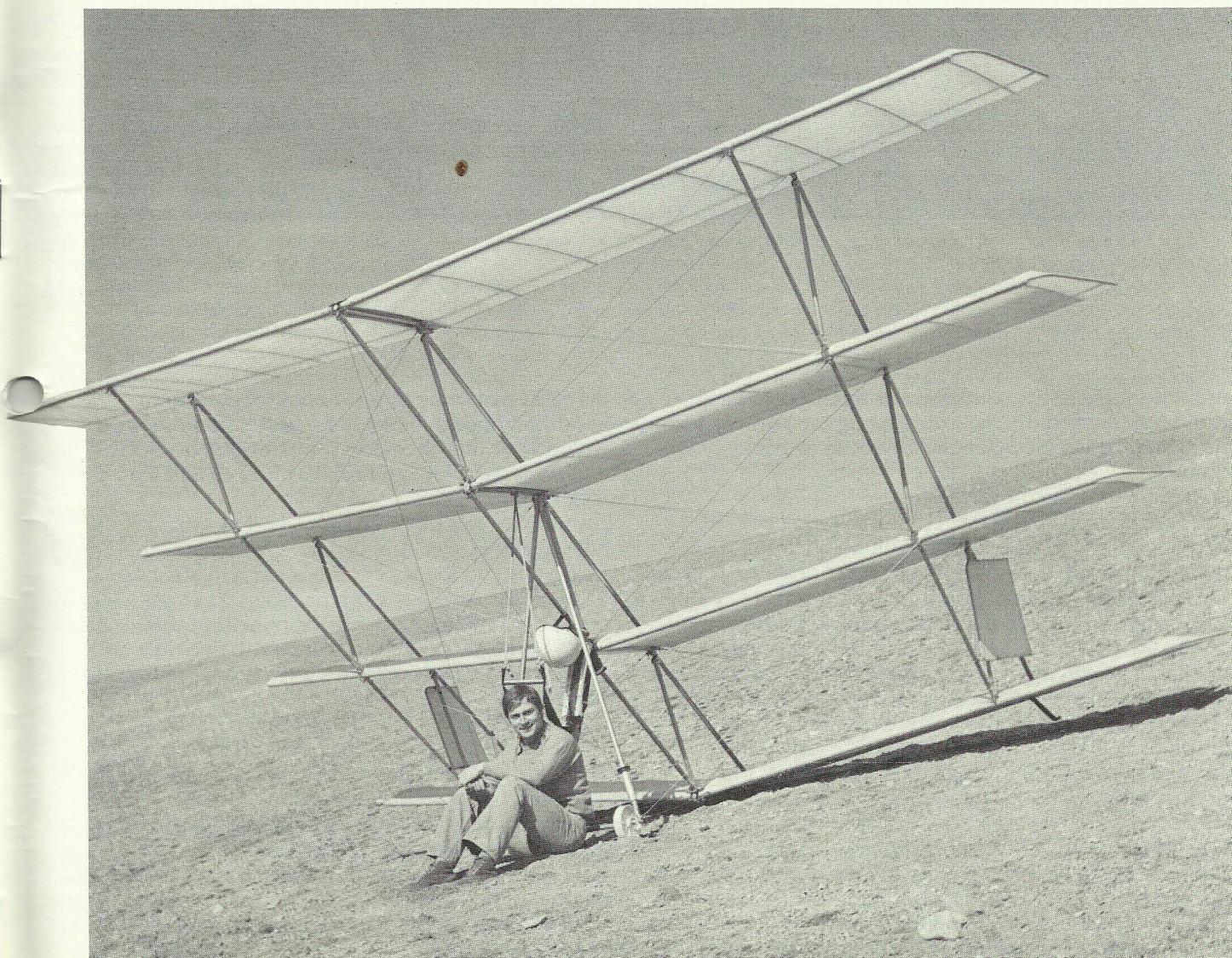


The Larry Hall Quadruplane —

# *a step closer to personal flight?*

by LARRY HALL with an introduction by RICHARD MILLER





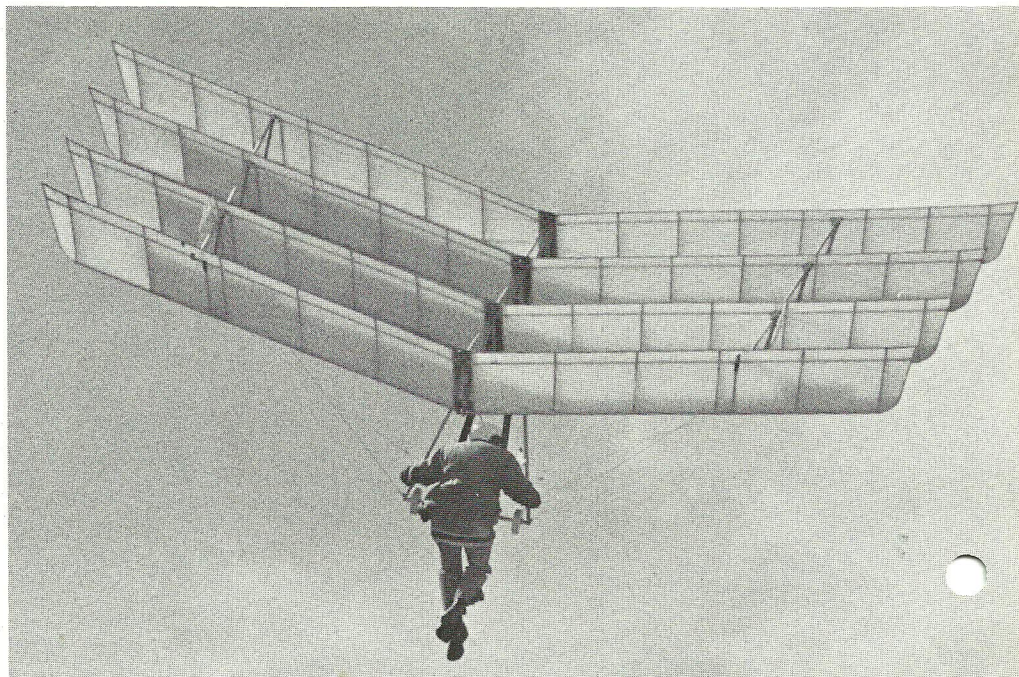
"Sometime in the future when the first hot rush of cliff-jumping has subsided, and accomplished hang-glider pilots can be counted in the hundreds rather than by twos and threes, there may well be a pause for a look back at some of the gliders built 50 to 75 years ago." — Richard Miller, *GROUND SKIMMER*, November, 1972.

For anyone interested in gliding and soaring flight, the early 1970's were a special time. The most obvious, or at least most visible reason for this was the high-performance fiberglass sailplane, for by that time all the innovations and developments that had been refined in the previous decades, most notably laminar-flow airfoils and monocoque construction, came together in aircraft of superb performance and stunning beauty. Anyone who had participated in the long development that had begun a half century earlier on the Wasserkuppe, or who was able to appreciate the magnitude of the problems that had been overcome in those fifty years, could look at the end product with a sense of great satisfaction.

But there was a shadow to this bright picture. The fiberglass sailplane was both complex and expensive to manufacture, and working alone only the most exceptional individuals, of whom there were less than a handful, could muster the energy, the knowledge, and the capital required to produce such an aircraft, so the job was transferred increasingly to factory workers. To the degree this happened, the homebuilder, the individual with the desire to realize his own dream, found himself less able to design and build his own personal flying machine.

The ultralight movement, the beginnings of which were the other noteworthy event of the early 1970's, changed all that. The sport of gliding, and the allied sport of glider designing, came down to earth with a bang — or a plop. One measure of the plunge it took could be seen from L/D figures which dropped a whole order of magnitude. But now the sport was within reach of many previously excluded, and it was quickly grasped. Thus, for the simple reason that the idea was established, it became possible to design, build, and fly one's own glider, and frequently at less expense than an R/C model would entail. It happened often enough that the result flew poorly or not at all — but the investment gave a quick return in education that was worth the admission price; and in most cases it was possible to pick up the pieces and, after a small spell for healing, try again.

While the participants were enjoying themselves, there were also treats for the observer. Over the years, the fiberglass sailplanes had seemed to converge and harden in a single form: A casual visitor to a national soaring championships could be forgiven for thinking that the rows of white



Arms extended, Larry Hall's "span" is a few inches less than six feet. His multiplane's span is a little over three times his own, but its wing area is 185 square feet!

gliders he saw had all come from the same mold. Now that mold was broken — shattered, in fact. There was a new attitude toward performance (mixed with a kind of benign ignorance about aerodynamics) that jolted the imagination and resulted in a great richness of design and innovation. Out of the workshops, sheds, and garages came not just monoplanes and biplanes, but tandem monoplanes, tailless biplanes, arc wings, ring wings, canards, and a good deal else not so readily classified. And Larry Hall's Quadruplane.

Larry Hall is not the first person to have built and successfully flown a multiplane hang glider, that distinction going to Matthew Sellers sometime prior to 1908 (*GROUND SKIMMER*, November 1972, page 12 and May 1975, page 30). It is highly unlikely that Sellers made more than short, straight glides, however, while Larry soars his ship regularly, or irregularly, as the case may be, and finds it soars well.

To me, Larry's quadruplane represents everything that's best about ultralight flight: careful design based on the best available information, excellent craftsmanship, and successful flight. But most of all it expresses one individual's response to an inner prompting, a response that is personal and unique. Everyone who sees the quadruplane fly, or who sees pictures of it in flight, will have to make up his own mind whether man's romping in the sky is better or worse for having a glider with four wings amid the myriad forms. For my part, I think soaring would be considerably poorer without it. — Richard Miller.

Upon seeing a quadruplane for the first time, one may well ask, "Why?" There are many reasons why I chose to build a staggered or stepped multiplane, a few of which I shall try to explain here.

I wanted a machine that could turn more sharply, fly more slowly, and soar in lighter lift than gliders presently available; something a little closer to the realm of bird flight or radio control model-glider flight. While watching model gliders fly, I often thought how neat it would be to stay up in winds as light as they stay up in and turn as sharply as they turn. It would not be possible to come very close to that ideal with any existing hang glider or ultralight, I thought, but if I could put a little bit of myself on each of several small gliders and fly them all in formation . . . ? That is what got me started on the multiplane idea.

A stepped multiplane like Matthew Sellers used, I feel, is the best choice. There is probably less interplane airflow interference using the staggered configuration; and by giving each successive wing, starting from the top, about  $\frac{3}{4}$ -degree less incidence, a positive pitch stabilizing force is set up, even though each individual wing might have a high-lift unstable airfoil.

#### Advantages of the Quadruplane

By some theories, the quadruplane is easily capable of outperforming all competitors. Take tip drag, for instance. Tip losses go up by the square



of the chord, or in this case down by the square root. Take any monoplane and "quadruplane it" and the tip drag of all four wings added up will be exactly one fourth that of the original monoplane! Or you could build a multiplane with similar performance to a monoplane but with a much reduced span for a much better roll rate and decreased turning radius.

Although interplane airflow interference, lower Reynolds numbers, and external bracing take their toll on such optimistic thinking, I am definitely convinced that there is a net gain with a multiplane. I think a cantilevered quadruplane would be the next logical step to explore these potentials further.

There are other benefits to a quadruplane, like always having plenty of help. No one would turn down a chance to help launch a quadruplane. It could be the answer to crowded airspace; I mean who would want to fly close to something creating eight tip vortices? Or take the problem of stalling; if you stall one wing, you still have three to go!

You have to put up with a little ribbing though. Someone is likely to say, "Ha, looks like you took off flying with

a set of bleachers!" And there is always someone with the old flying venetian blind gag.

#### Flight Characteristics and Performance

Although I have just begun to explore the glider's potential, I can tell some things about its flight characteristics and performance. When holding the glider ready for takeoff I found the tail quite heavy, requiring tail skids, but the short span makes it easy to keep the wings level. Once airborne, the quadruplane's flight sensation is unlike any other hang glider I have flown. In a turn, I feel almost as if I were swinging out like a pendulum until I reached the desired bank angle. I can feel the tip rudders causing the glider to roll as well as yaw since the rudders are placed behind and below the center of gravity. Spectators on the ground have commented that the rolling motion seems to pivot around a point centered at the root of the top wing, which is ten feet above me. This would explain the pendulum feeling.

If lift is suddenly encountered, I get the feeling of going up in quite an efficient way. Sailing along in smooth air,

the glider feels steady and safe and at home in the air.

On my first few flights, I was a little startled as I glanced out at the wings, and it seemed I could almost reach out and touch the wing tips.

Coming in for a landing, the low inertia of the small-span wings results in immediate response to rudder corrections. The quadruplane flares easily and touchdown is always light and almost at a standstill.

If compared to a current generation high aspect ratio Rogallo, the glide angle seems somewhat less, but the sink rate so far appears to be as good. Let's compare it to a monoplane glider of the same span and wing area though, which is the only fair comparison. Such a glider would have a span of twenty feet and a chord of ten feet with a resulting aspect ratio of two. Compared to that, I think I can safely say that performance is very good.

#### Structure

The type of construction I chose is similar to the *Icarus II*; aluminum-tubing spars, wire braced, styrofoam ribs with dope and fabric covering. The rudders are actuated by twist grips lo-

*Designer Hall says the location of tip dragger control surfaces well below and behind the cg give the multiplane exceptional roll and yaw control.*







During this early flight, the wind rose to over 20 knots and Larry was obliged to make a near-vertical descent back at the crest of the hill.

cated on the down tubes of the control bar. The control bar is not actually a structural member of the glider, as is the case with most hang gliders. It is merely something to hang onto while flying and helps support the glider on the ground. Other types of construction may lend themselves well to the multiplane idea. Foam and fiberglass may be ideal for a glider with so many small wings.

I would definitely encourage anyone who is contemplating building a step glider or experimenting with other new and old ideas. It is a tremendous thrill and a great satisfaction to build and fly your own design.

#### SPECIFICATIONS

##### Spans from top

(No.1) 20' 10"; 19' 10"; 18' 10"; 17' 10"

Chord 2' 6"

Wing Area 185 square feet

Dihedral 6 degrees

Weight Approx. 65 lbs.

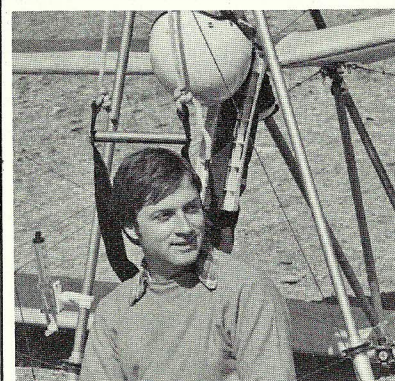
Stagger 45 degrees

Sweep 10 degrees

Airfoil Similar to *Icarus II* without reflex

Rudder Area 2.36 square feet each

Overall height 10 feet



No one in Morgan, Utah, thinks of 28-year old Larry Hall as a secretive person. Yet, two years ago, when he started working on his radical new quadruplane ultralight, he was glad to be living in the small valley community with its 600 souls somewhat isolated from Salt Lake and the outside world beyond the Wasatch Mountains. He wanted *a fait accompli*, a completed and successfully flying machine, before the aviation press found out about his project. Thus, it was a surprise when a Japanese TV crew recently turned up with a request to film his activities shortly after he had made his first flights. Word of a new idea in ultralights gets around fast, it seems.

Larry is one of that motivated group of enthusiasts who is pursuing the idea of personal motorless flight in micro-weather regimes still not completely explored and available to soaring pilots. He wants a machine whose small-radius turn capability and low sink speed will make possible human soaring flight in the narrow lower-energy thermals that still remain as the exclusive prerogative of bird flight and RC models. The Hall quadruplane may be an important step in that direction.

"I became excited by this concept back in 1971," Larry recalls, "when I saw *Soaring's* pictures of Dave Kilbourne making one of the earliest foot-launched soaring flights along Mission Peak ridge near San Francisco. I was studying aeronautical engineering at Utah State; it was clear there wasn't much known about low-speed aerodynamics, and I came to the conclusion that for an individual like myself without access to research facilities, a pragmatic cut-and-try approach was the most promising route. Then the journal carried some information on Klaus Hill's work and I went over to Morgan to see what he was doing."

The two hit it off right from the start and Larry worked with Hill during the next three years. The two most notable results were the *Fledgling*, and the *Super Floater*. The former is a collapsible, foot-launched flying wing, and the second a rigid-wing ultralight which has a skid and a wheel, but which can be foot-launched too.

At this writing, Hall has not had the time to do much flying or testing with his quadruplane due to the onset of winter and the demands of his ultralight variometer business. But when spring comes to the valley again and the thermals begin stirring along the slopes, Larry will see if his quadruplane has brought him any closer to his quest for personal ultralight soaring.