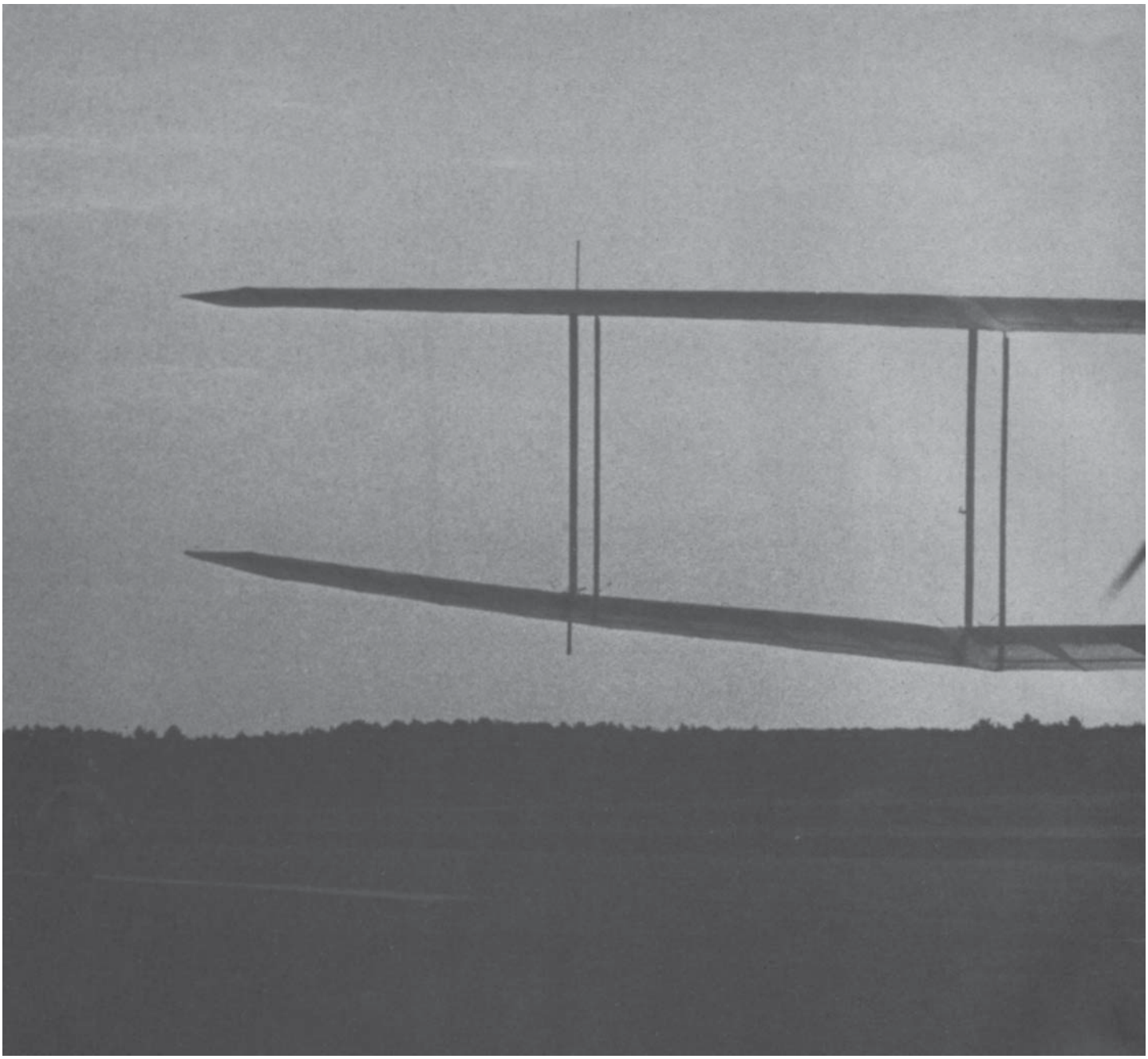


"Don't step on the bottom of the cockpit – your feet will go right through. Strap your feet in very tightly. Do everything smoothly. Pedal gently at first and when we say POWER! give it all you've got. If your wings bank to the left, pull the stick to the right. That is important. What do you do if the left wing tilts downward?"

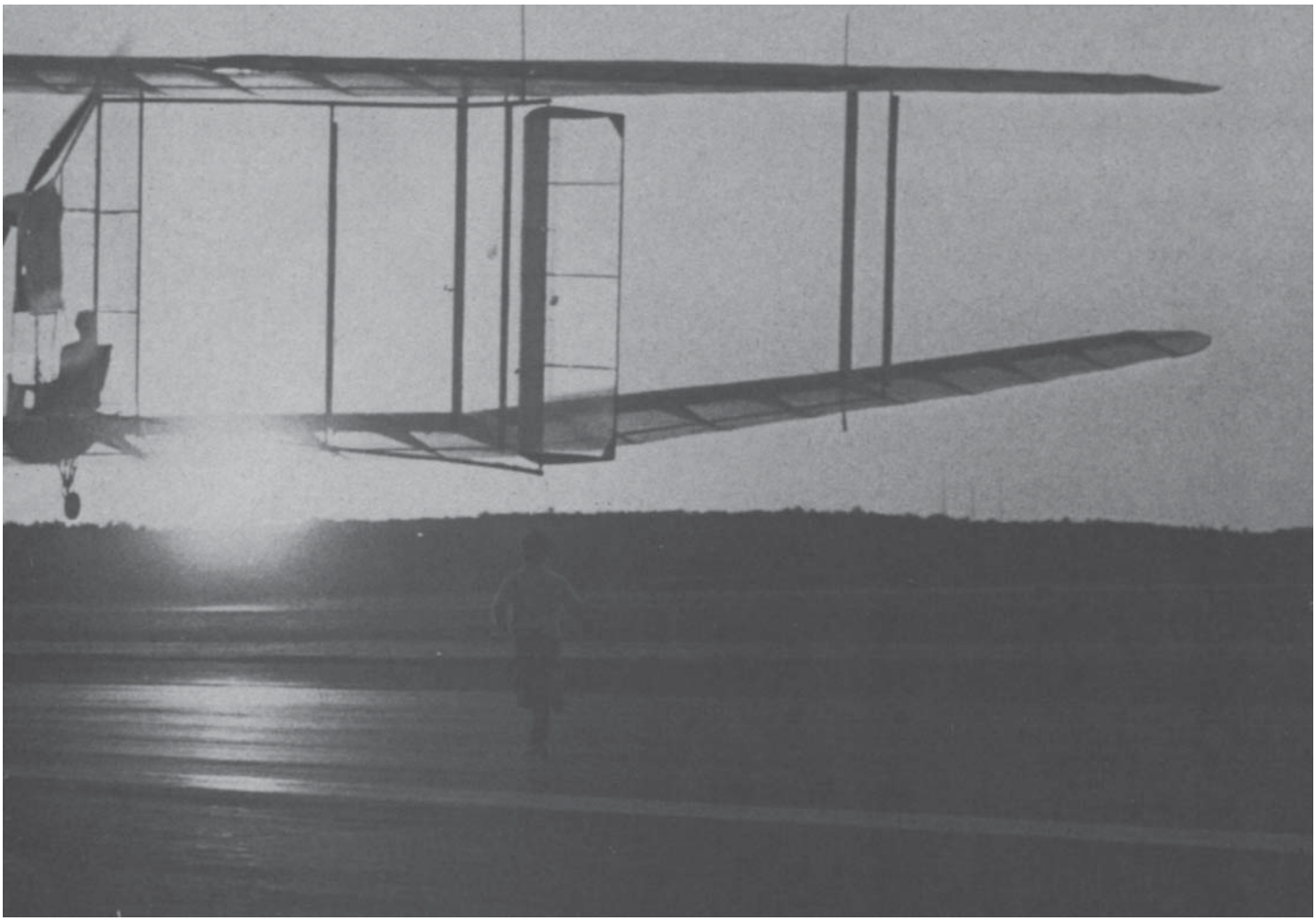
"Pull the stick to the right."

"Yes. Your pedal speed determines altitude only; the stick motion determines speed. Don't think about it, just do it." Guppy Youngren, '79, is intently explaining the mechanics of the Chrysalis human–powered airplane to me as I prepare to be its pilot and engine. It was his and a few other enterprising M.I.T. students' baby. it cost them and about 20 intermittent participants 3500 hours of work, and it flew the first time out. Now it was a matter of refining the details, going for longer flights, experimenting with turns.

They took a lightning approach from design to production: 91 days between the first construction and roll–out day. weeks where the hard core (Bob Parks, 79. Harold "Guppy" Youngren, 79. John Langford, '79, Hyong Bang, '79. and Mark Drela, '82) sometimes averaged 60 to 80 hours of work. Their experience on model airplanes (the three competed in Bulgaria last fall for a model rocket competition world championship and Youngren won) was of great value – it was the two radio controlled scale models they built first that took the test beatings, flying in the du Pont gym (to the dismay of basketball players). The huge and graceful Chrysalis was built after most problems were recognized.

The history of man–powered flight at M.I.T. is not glorious. A total of nine years, three generations of students and 20.000 man–hours produced two airplanes. Neither got off the ground. In December, BURD (Biplane Ultralight Research

Chrysalis,
Human–Powered Airplane: it Flew the First Time Out!



Device) was scheduled to be trashed because of lack of hangar space – and waning enthusiasm – after the winning of the coveted Kramer Prize for man–powered flight by the Gossamer Condor, built by a California group led by Dr. Paul MacCready. On a whim, Bob Parks and Guppy Youngren (model airplane addicts) asked permission to give it a try with model airplane engines replacing the second pilot (BURD was built for two). It didn't work.

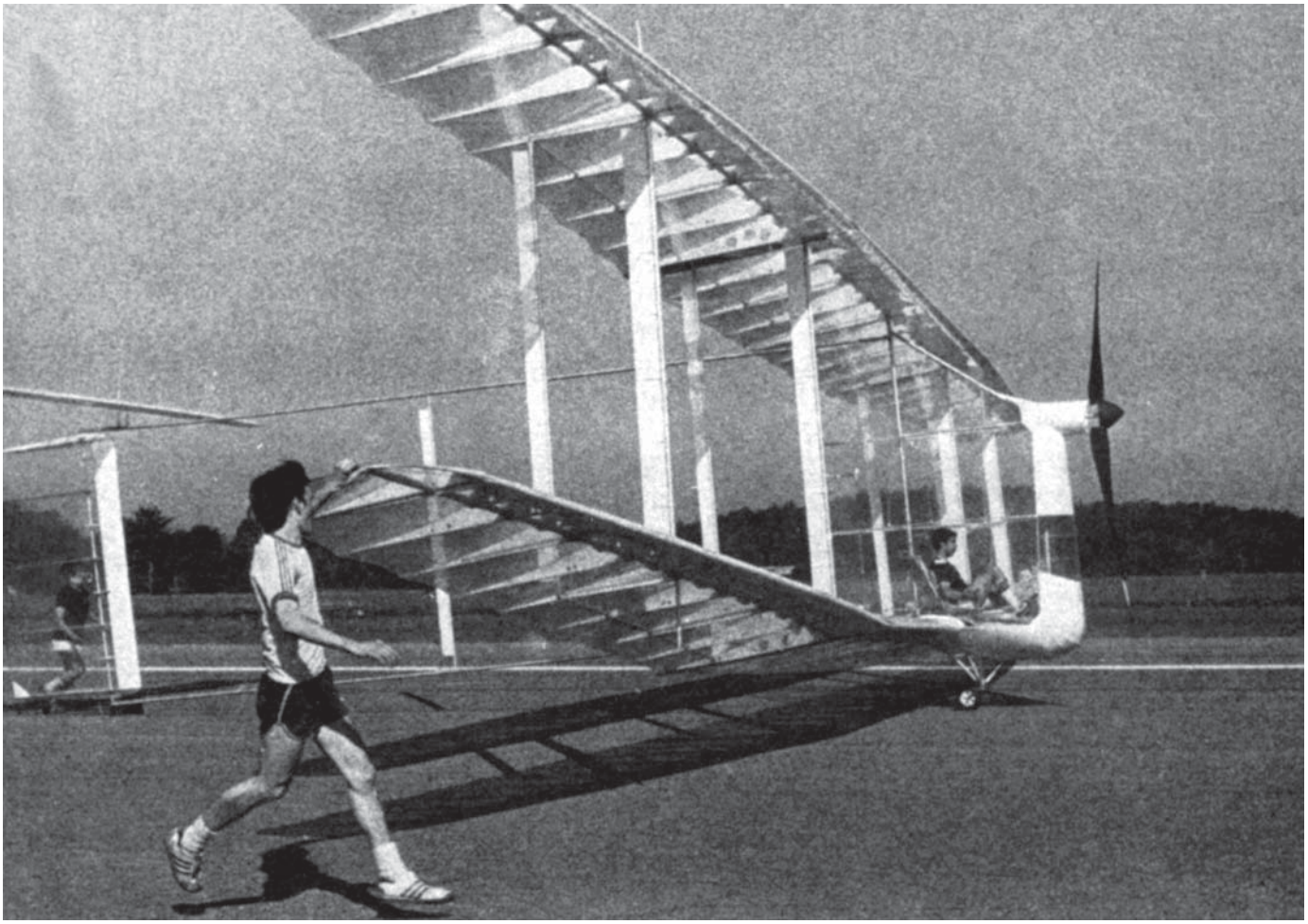
It was an undignified end to an intricate design. But it was the beginning of a fascination with the problem, quickly escalating into total involvement, for Youngren, Parks. and Langford that resulted in a completely new effort.

In the beginning they could be found. binoculars in hand. on the ground floor of the Smithsonian in Washington inspecting the Gossamer Condor. But first priority: make something of their own. "We called ourselves the 'Chrysalis Group,' " says Aero–Astro Professor Eugene Larrabee, their advisor. "with the thought that whatever came out of our effort would grow into something else."

Bob started working on the design over Christmas vacation, Guppy joined in when he came back, and by the first or second week in January they had a design that was almost recognizable as the finished plane.

"We are interested in hard facts," emphasizes Professor Larrabee. "Our philosophy," adds Youngren, "is ease of construction, ease of repair; the same ground rules held by the MacCready group. The key: simplicity, light weight, slow speed, and external wires (if you fly slowly enough, the drag from exposed wires is not detrimental). "Inherent in the idea is that the power must be incredibly low, ' says Langford. "People don't generate much power." (Chrysalis is currently the slowest airplane in the world at 10 miles per hour flying speed.)

More than half the money went for Aluminum tubing alone.



MacCready approached his plane as a scaled–up hang glider; members of the Chrysalis Group approached theirs as a scaled–up model airplane. "Stability and control where our biggest problems, so we decided to build a radio controlled flying model airplane to test it," explains Parks. "By testing the model we could hope to build something that would work the first time." When the model could take off and maneuver, the team was ready to build it big: picture a 72 foot wing span.

They registered for the same special projects course for spring semester. Then they presented a detailed project schedule and requirements to Department Chairman Jack Kerrebrock to see if he could give them funding. Halfway through he stopped them. "How can I say no?" he said. They got $2,500 – all they asked for.

More than half the money went for aluminum tubing alone. "The aluminum tubes we needed didn't exist, so we designed the airplane around what aluminum tubing was available. Then we bought half of the current supply, in the country. I finally got convinced we would do it when a big box arrived from California with $1300 worth of tubing," says Parks. It wasn't thin enough (it had a wall thickness of 0.02 inches which needed to be reduced to 0.015 or 0.011 according to where it was used), so they had to thin down the walls themselves.

They set up a one–day–only chemical milling plant behind Building 17, complete with hot (160° F.) lye heated by stoves, gas masks (the hydrogen gas given off permeated everything), face shields, rubber gloves and aprons; the solution boiling and bubbling like a witch's brew in 13–foot–long tanks fashioned out of the boxes that housed the tubing.

Careful builders; the same vision

Finally the materials were ready; it was early March. Now mass production started. "We had rib parties every weekend in the basement of the aero department – 12 people doing organized work. Pretty soon everyone knew what it would look like – we had the same conception in mind, even without final blueprints," explains Guppy. "They were talented people who are careful builders working toward the same end." Bob built a machine that cut thin slices of styrofoam (no one sells it in the 1/8–inch thickness that was needed) and they glued balsa on top and bottom. "It was an immense effort to build the wings – it took from the second week in April until the first week in May.", says Youngren. "First we built a 12–foot full–size piece of wing for a test section," adds Parks. "Essentially it was one chunk out of the middle of the wing on which we tried all the techniques to see what kind of problems we would run into on the real plane. And we ran into lots of problems." (Most were

Foam padding – lots of it – had to be stuffed behind me in the seat so my legs could roach the pedals with a slight bend in the knee when the leg was outstretched; the bike was built for a 6–loot person and I'm 5'4". Sitting in what seemed like a Saran Wrap compartment with bright shiny morning sun reflecting off the runway and reverberating inside my little cell, I felt like part of a fantasy. This is it and don't blow It, I kept thinking. Listen to the directions, concentrate on pedaling.

That was surprisingly easy: the motion was natural with feet strapped tightly. It took much less effort than 1 expected – I felt the plane lift off before I was putting out 100 per cent effort.

I looked down at people running alongside, one shouting directions; then, confusion. The stick had to be maneuvered carefully to steer and I had no Idea what I was doing. The plane was moving off to the left and sharply pointing up.

"Right! Right!– they kept saying and I noticed the left edge of the runway getting much too close –1t seemed a very poor place to land. Suddenly the nose lifted too high and I lost altitude. My landing was anything but smooth: I had stalled. Damage to the right wing was minimal, but enough to end flying for the day. No one seemed upset, so I just sat there for a minute and quietly noticed my knees shaking. – M.L.

Photos: page A2–A4, Bob Parks, '79; above, David E. Nawrocki

with the covering, to keep it taut.)

"The only way to get anything done is to go for 18–hour sessions at a time," explains Youngren "So much is hanging on one piece building on another, you can't stop. When we covered the plane with plastic film, the session ran from Friday afternoon to Tuesday morning. (The job had to get done – we had a truck arriving Tuesday morning to move it to Hanscom field.) That three–day weekend was 73 hours of work. It generated its own enthusiasm – like a fantasy."

The propeller was the key to the project and "where we get tied into history," they said. Based on Professor Larrabee's design theories, Bang wrote a computer program used to design the propellers in the preliminary model of the Chrysalis and the Gossamer Albatross (MacCready's human–powered airplane that won the prize for crossing the English channel last spring). Chrysalis' final prop came from it, too. Each seven–foot blade of the Chrysalis prop is made of styrofoam covered with Kevlar, weighing 22 ounces. Total weight is three pounds.

"One foot off the ground is a lot – because you did it yourself."

Finally a large space was needed to assemble the Chrysalis. They arranged to use a former Simplex building (abandoned industrial space near M.I.T.) with no heat, a leaky roof, huge holes in the floor and a covering of 1/4 inch of dirt. Part of the budget was unexpectedly used to pay $200 to have lights installed. There the wings were assembled: six wing panels, 24 feet long, six feet wide, with an average weight of eight pounds.

On May 8, a 40–foot moving van transported the plane to Hanscom Field in Bedford, Mass. The pressure was on for a first flight; hangar time was limited. Flying weather is crucial; dawn is the best time for the optimal still air. "It's so fragile that it could be ripped apart in very little wind," explains Youngren. At what seemed like the last minute (or it would never get off the ground), Friday, June 5, in wretched weather (winds of 7 m.p.h.), Youngren pedaled the Chrysalis into the air. It worked the first time – a 15–second flight for 30 feet, three feet high. "It can be one foot off the ground and that's a lot, because you did it yourself," explains Guppy, a bicyclist and experienced sail–plane pilot. "When in the air it's so exciting the tendency is to forget to pedal." That first day was especially nerve–wracking. "It was almost impossible to hold it down – like trying to fly a balsa glider in a 40–mile gale," he adds. The airplane needs 4/10 horsepower – like a bicycle in 10th gear, 80 strokes a minute.

Now came a reprieve: extended hangar time. Each day after that was modification, repairs, learning by trial and error, "back–of–the envelope engineering," said Guppy. Flying time and height increased; experimenting with turns began.

Parks describes two goals for the 95–pound airplane: to achieve better performance, and to let everyone else fly for fun (20 or 30 people have made contributions of time and effort). "Building and flying the Chrysalis was a once–in–a–lifetime opportunity," says Youngren. ("You look back and say here's this giant thing – as big as a house – and we built it.") And, indeed, an interesting way to get a job. He, Parks, and Langford will continue their teamwork at Lockheed this fall in Burbank, Calif., a stone's throw from their competitors and friends,

"it was an immense effort to build the wings – it took from the second week in April until the first week in May," says Youngren. There were six wing panels, 24 feet long, six feet wide, with an average weight of eight pounds.