The Little Chopper that Could

By Paul Arlton

A Brief History of the LMH-100 and Lite Machines Corporation

Slowly Paul pushed the throttle forward and the crackle of the engine intensified. The cloud of castor oil vapor floating around the fuselage danced and then darted away as the rotors accelerated. It lifted off the ground, and I could tell it was stable. I marveled as it hovered five feet off the grass. In order to sit still in the air, every force must be in perfect equilibrium. The main rotor must precisely counter the force of gravity and the side thrust of the tail rotor. The tail rotor must exactly cancel the torque of the main rotor. And to think that the powerplant relies on a single piston .4 inches in diameter cycling at close to 300 times per second. It works. Amazing.

That was October 7, 1989. After many years of continuous development, Prototype II, a precursor to today's LMH-100 helicopter, finally left the ground. In case you're not familiar with the LMH-100, it is the first mass-produced 1/2A-class (.049 powered) helicopter in the world, and it flies on roughly the power consumed by a 75 watt light bulb. In comparison, .30 to .60 size model helicopters use ten to twenty times more. The LMH-100 helicopter has features not found on other helicopters: semi-flexible main rotors that can fold up to reduce damage in crashes, a special Subrotorä stabilizing rotor that minimizes the reversed airflow commonly found near the rotor hub, and a light-weight mechanical Arlton Gyroästabilizer that replaces the electronic gyro and extra capacity receiver batteries.

The LMH-100 evolved from a simple idea, and is the culmination of innumerable incremental advances in small-scale aerodynamics, material science, and manufacturing technology. But to the people involved in its development, the LMH-100 is more than a model helicopter, it's a learning experience. It's an excuse to learn about and apply new design and building technologies on a small scale that might otherwise involve many separate companies. The LMH-100 is a reflection of the people involved in its development (Dave Arlton, Paul Arlton and Paul Klusman) who all contributed to the design, and who learned something in the process. What follows is a brief account of how the LMH-100 and Lite Machines

I am Paul Arlton. I like small, simple, cheap things. My favorite RC airplane is a two-channel Cox .049 powered F4F Hellcat I built from scratch in a weekend from styrofoam and Econocote for about $10. My brother, Dave, likes big, expensive, mind-numbingly complicated things. He is infatuated with his Shlüter Champion helicopter and computer radio which together cost about $1,600. I get hives flying something that expensive.

As a Christmas present in 1981, Dave received one of the first IBM personal computers. It cost about $4,000 (I suggested a $350 Atari, but he wouldn't go for it). Having nothing better to do (than engineering homework) we developed an interactive graphic software simulation (a video game) in the early 1980's named GATO that sold enough copies that we did not have to find real jobs after college. We spent the next several years on our own developing software and learning about computers. Although we did not know it at the time, everything we eventually would do with the LMH-100 would hinge on our knowledge of computers.

One humid summer day in Indiana in 1988, Paul Klusman, an accomplished RC helicopter pilot and friend of ours, brought over a free-flight rubber-band powered helicopter he had designed. As I watched it fly, I thought it must be possible to build a small, simple RC helicopter powered by a Cox .049, just for fun.

I knew from my college days in aerospace engineering that slow speed and large span is an effective combination for airplanes (RC gliders can carry a lot of weight with an .049) so I decided to try a "rotary glider" concept. I found low-speed airfoil data in the NASA Star documents at the engineering library at Purdue University, and built a rotor to test. In my spare time over the course of several months, I made various slow-speed rotors from styrofoam and balsa wood, and spun them with a hand drill. They moved volumes of air, but I had no idea how much lift they produced or the power they consumed, so I made a simple test apparatus from a sheet of plywood. As I developed various assemblies (like the clutch and tail rotor gear box), I bolted them to the test stand to measure their performance.

At this point, our most sophisticated prototyping tool was a hand-held Dremel motor tool. Since I had no good way of making complicated plastic parts, I usually built them of wood (birch sticks or plywood) and duplicated them using silicone rubber molds. With a mold I could make several identical parts to test. For a prototype gear box for instance, I would mix laminating epoxy and 20% to 30% of 1/8" milled glass fibers (by weight) in a Dixie cup, de-air the mixture in a vacuum chamber (a hand operated automotive brake-bleeding pump and a jelly jar), and pour the slurry into a silicone mold. When hard, the resulting material was mechanically similar to injection molded acrylic plastic. In a similar way, I cast gears from two-part polyurethane (94 Durometer hardness) purchased at our local industrial supply shop. Polyurethane is extremely abrasion resistant, and can simulate parts made from injection molded nylon.

As I continued to develop parts, I found that I needed more sophisticated tools. We took the plunge and bought an air-conditioner vacuum pump (about $300) and a small Unimat hobby lathe and mill. We thought long and hard about the price of the lathe ($1,100 fully tooled), but it was well worth it. Without that lathe we could never have made parts to the precision we needed. And even with good tools, my success rate in building prototype parts was about 25%. I usually made parts three or four times (punctuated with much stomping and swearing) before I got them right.

After many months of testing it became clear that big, slow rotors could lift only about as much as the test apparatus weighed. There was no extra lift available for radio equipment. This situation prompted a re-evaluation of the concept. Big, slow rotors produce a lot of lift, but they are also heavy. So what about small, fast rotors? I made a simple gear reduction mechanism for our Dremel (which, coincidentally, puts out about as much power as a Cox .049) and bolted on a 16 inch propeller purchased from our local hobby shop. It produced about half the lift generated by the large rotors, but weighted about 5 times less.