

## THE DEVELOPMENT OF "THE WORLD'S FASTEST BICYCLE," LIGHTNING X-2

by Tim Brummer

Many of the ideas and motivation for building Lightning X-2 began with my involvement with White Lightning, the record-setting fully faired tandem tricycle. While students at Northrop University, Don Guichard, Chris Dreike and I did all of the development and test riding for White Lightning.

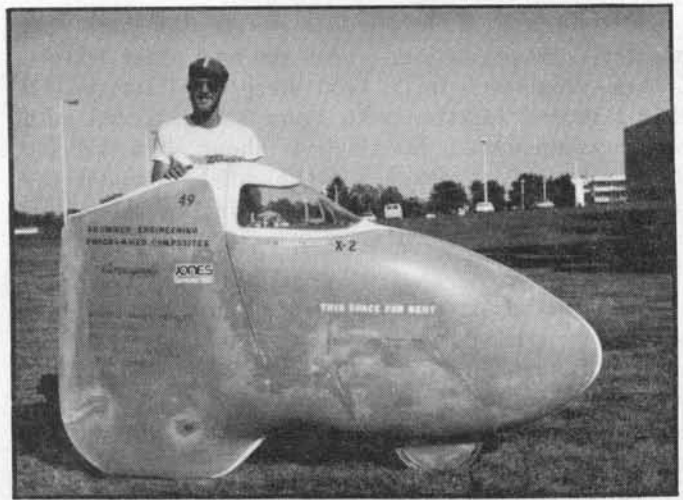
It was always an exhilarating ride to crank that vehicle up to 22+m/s (50+ mph) on our test road behind Los Angeles International Airport, especially when a back tire would blow. (Initially, we had a problem with the fairing rubbing.) This might sound dangerous but the machine would simply settle down and slide to a stop with very little damage. We would just put on another sew-up and take off again.

However, it wasn't very practical to take White Lightning down to the corner grocery store since it had a ground clearance of 13mm (1/2 inch) and a 24-m (80') turning radius. I can recall one instance when we rode down to the hardware store to buy a small part. We had to stop to get out and to pick the trike up to get around normal street corners.

During 1979, another Northrop student, Roc Fleishman, contacted us to say that he wanted to build a single-rider HPV suitable for street use. We



LIGHTNING X1, August '82



LIGHTNING X-2, October '83

came up with a design that is more maneuverable and higher off the ground than White Lightning; we called it Roc's Rock-it. It has a three-wheel layout with one 24" wheel in front and two 18" rear wheels.

The front wheel is driven with a five-speed set up. The rear wheels not only steer the bike, but also allow it to lean while going around corners. It takes quite a bit of time to master the unique steering arrangement. The best speed to date is 20m/s (45 mph). With a better fairing I am sure it would go over 22m/s (50 mph).

It turns out that the main problem is that the seat is too low for street use, even though the rider's head is 200 mm (8 inches) higher than on White Lightning. Riding along on the street looking at car hubcaps can be disconcerting, but Roc does ride it around on the L.A. bike paths quite a bit.

Meanwhile, back at the drawing board, a recumbent bicycle seemed to be the best since one can get the seat up high enough to be safe and still be narrow enough to ride along the shoulder of a highway and not halfway out in the lane. After some analysis, a wheelbase similar to that of a standard bike seemed best. I could not see making a single-rider recumbent with a wheelbase of a standard tandem. And after riding a Hypercycle and experiencing its poor handling, I wanted to avoid making it with a short wheelbase.

One problem my bike does have, however, is that one's feet hit the front wheel on slow, tight corners or U-turns. But after a little practice, one develops a pedaling technique to overcome this design trade-off.

The first bike I made was a 22-kg (50-lbm) adjustable monster that used some parts from a bike I bought for \$25 in a junkyard. I rode it around for

some time and it helped me decide the best seat position, crank position, wheelbase and other factors. I then progressed to a 4130 steel-tube-frame model that I brazed together with brass and outfitted with better components. It weighed about 13.6 kg (30 lbm). Though I mounted the handlebars under the seat, I feel that having the bars over the knees, as on the X-2, gives better control for fast maneuvering.

Progress during this stage was slow since I had purchased a used house and was spending a lot of time and money fixing it up. I also had to rebuild the engine of my car. During August of 1982, some friends of mine asked if I was going to race at the upcoming Human Power Speed Championships in Orange County. It sounded like fun but I knew my bike wouldn't stand a chance without a fairing. So I quickly threw together a partial fairing made of aluminum tubing and Mylar.

The bike was really Lightning X-1 although not advertised as such. It turned a not-so-fast 16.5 m/s (37 mph) in the 600/200-meter event. In the drag race, I did have the pleasure of beating a standard bike equipped with a Zipper fairing. During the road race a friend slid out on some gravel in a turn and put the bike out of further competition. A Vector later slid out in the same corner.

In 1983 I decided to make an improved frame using what I had learned from my previous bike. I ride this bike around quite extensively and have gone on a few weekend trips of 100 miles or more.

In May, I was at Don Guichard's house watching the Indy 500 on TV. We got to talking about the upcoming HPV Championships and Don said he could probably get some Kevlar donated if I wanted to make a fairing for my bike.

I drew up a fully-enclosed body design that fit nicely around my bike. I had decided early-on that the rider should be able to get into the bike and start it himself, since I was going to be doing all of the test riding myself with no support crew. That is why X-2 has its unique "landing-gear doors" that open automatically when your feet hit them.

Then there was the long and arduous task of making the body molds. Fortunately, I had some help from about five kids aged 9 to 12 in my neighborhood, especially during the plastering part. All I had to do was feed them ice cream.

I constructed the base of my molds from 2" x 6" wood (about 50 x 150 mm) and 3/4" (12 mm) plywood. I placed aluminum templates with 6" (150 mm) spacing on this. Plaster was then applied between the templates to a depth of 25 mm (one inch).

About four plaster applications are required from rough to smooth. After the plaster dried, I spent many hours sanding and painting with primer to achieve a good surface.

The next step was to lay-up a fiberglass female mold on the plaster male (see photo). I made the glass about 3 mm (1/8") thick. I took the molds down to Los Angeles where Don helped me make the body parts at Programmed Composites, where he works. We used ovens to cure the epoxy in the Kevlar at 120C (250F). Don had gotten the Kevlar donated and we used some honeycomb core left over from White Lightning. The face sheets and the core are layed-up and cured together in one step, with the resin in the face sheets being sufficient to bond them to the core.

Making the parts took us three 16-hour days. Mold release was a problem as the body parts stuck to the mold and it took an extra full day to get them out. I took the parts back to my garage where I glued them together, bonded some supporting structure inside and made all the cut-outs.

The next step was to attach the fairing to my bike. About the only change I made to the bike itself was to increase its gearing size. I took the completed vehicle out for its first test run two days before sending it to Indianapolis.

I shipped it to Indy in the fiberglass female molds since I didn't have time to make a regular shipping crate. All the hassle I went through getting a trucking company to ship it is a story in itself: it almost didn't get sent. My first day in Indianapolis, one day before the racing started, I was lucky enough to meet Carl Sundquist. If it hadn't been for his athletic abilities, the record of 24.49 m/s (54.78 mph) would not have been set. When the timers announced his record time it made all my months of hard work worthwhile.

About the only negative feeling I have about this whole episode is the blasé attitude of the bicycle industry. Before I started making my body, I wrote to twenty bicycle companies and component suppliers concerning sponsorships. The smaller ones at least wrote back and wished me good luck; the larger ones didn't even reply.

The amazing thing is that on Lightning X-2 even I, an average weekend bike rider, could go out and beat the world's best riders of conventional bikes anytime.

Maybe if all you readers told your friends to buy recumbents, then the bike manufacturers might get their heads out of the sand and take notice.