Cherokee-M

UPSCALING THE CLASSIC ESTES CHEROKEE-D ROCKET

by Dan Michael

My obsession with rocketry started in the summer of 1966 when I was only 8 years old. As I sat waiting for my mother to finish at her hairdresser, I continually kept staring at an old 1966 Estes catalog wishing I could have everything in the catalog. Believe it or not, I still have that catalog! Even back then, rocketry was a pricey hobby, and my weekly allowance did not allow me to get started.

It wasn't until the fall of 1969 when I was in 6th grade that I finally got into rocketry. My science teacher was really into rocketry, so on nice days we would go outside during science class and launch rockets. After that, I started buying, building, and launching rockets one after another. By 1976 I had over 100 rockets in my collection!

One rocket that quickly became my favorite was the Estes "Cherokee-D." I built three of them, simply because the others ended up in my neighbors' trees! I always remember how straight and true that rocket flew.

So, I figured an upscale of this rocket would really be fantastic. I took the dimensions of the original kit and settled on a 5.79x upscale. My plan was to use 7.67" phenolic airframing, so I divided the 7.67" dimension by the 1.325" original dimension and came up with 5.79, this being the multiplier. All the original dimensions need to be multiplied by this figure to attain proper measurements for upscale parts manufacture. The original nosecone is essentially a 4:1 conical nosecone, as is the fiberglass upscale ver-

sion.

As you read through my construction phases, it is obvious I build things incredibly strong. But in doing so, there is no doubt about the strength and structural integrity of the project. I began construction by first making a template for the fins. The fins were cut from 1/2" Baltic birch plywood. Being a woodworker, there is a significant difference between Baltic birch plywood and regular birch plywood. They will both work adequately, however, the difference is that Baltic birch plywood has many more laminations than conventional birch plywood, making it much stronger. After cutting out the fins, all the exposed edges were shaped with a 1/4" round-over router bit. (Photo A.)

Then it was time to make all the centering rings and bulkhead plates. Again, all rings and plates were made from 1/2" Baltic birch plywood, except the altimeter end plates, which were made from 3/4" Baltic birch plywood. The easiest way to make centering rings or any bulkplates, is to take a section of airframe or coupler tubing, and run a pencil around the inside or outside perimeter onto your wood material. I then cut everything out using my bandsaw and sabre saw. I cut everything oversize or undersize, depending on the part, then I sanded all parts to an exact fit. I used a center finder to locate the exact center of the plates. Most of all, positioning of anything is dependant on the center location.


Photo A.


Photo B.

After marking the airframe, I used a straight edge (I used my table saw fence) to draw the lines for the fin and rail button locations. Since I made the fins out of 1/2" material, I needed to measure 1/4" outward in each direction from the centerline to mark the fin slots. After doing so, I used my Dremel tool to cut out the slots. (Photos B and C.)

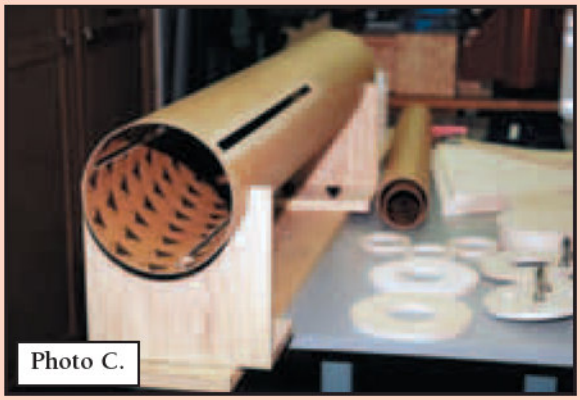


Photo C.

Next, I built the motor tube/fin mount assembly, centering the 75mm motor tube inside a 4" tube. The principle behind this idea is that the heat developed from the motor will not have an influence on the epoxy fin bond and fillets, since the fins will be attached to the 4" tube, and not the motor tube. (Photo D.)

I build all my rockets with a centering ring fore and aft of the fins. From the start, I knew this rocket was going to big and heavy, so I extended the motor tube to accommodate the longest 75mm motor. I added an additional 15" section to the existing 36" section for a total of 51". I used four centering rings on the entire motor mount assembly due to the extra

Photo D.

long motor tube. When I assemble booster sections, I always build them with careful planning in mind. I work out a way to see to it that each and every centering ring receives a large fillet of epoxy on each side. In this case, the forward centering ring for the fins was epoxied to the motor tube assembly. This entire motor tube assembly was then epoxied in place just forward of the fin slots. To keep the assembly centered, the aft centering ring needs to be temporarily set in place. After the epoxy has cured, the third centering ring needs to be epoxied down onto the motor tube past where the coupler will be positioned. Again, an epoxy fillet can be added to the forward side of this ring. The fourth centering ring should now be epoxied inside the coupler about 1/4" behind where the forward end of the motor tube will end up. Then the coupler/centering should be epoxied in place. Prior to this assembly, I installed and epoxied a 3/8" stainless steel U-bolt into the front fourth centering ring for the recovery harness.

It is always a gamble later, after the booster section is closed, to efficiently attach rail buttons. If you miss the centering rings, you've got a problem. The solution to this is to epoxy a piece of hardwood the entire length of the booster section, and to position a piece forward to allow easy and strong attachment of rail buttons. (Photo E.)

My motor retainer is a 75mm Aeropack. Positioning of the motor retainer mount ring is important, so when drilling the aft centering ring be sure to have it centered so that the motor will easily slip into the motor tube and seat itself in the retainer.

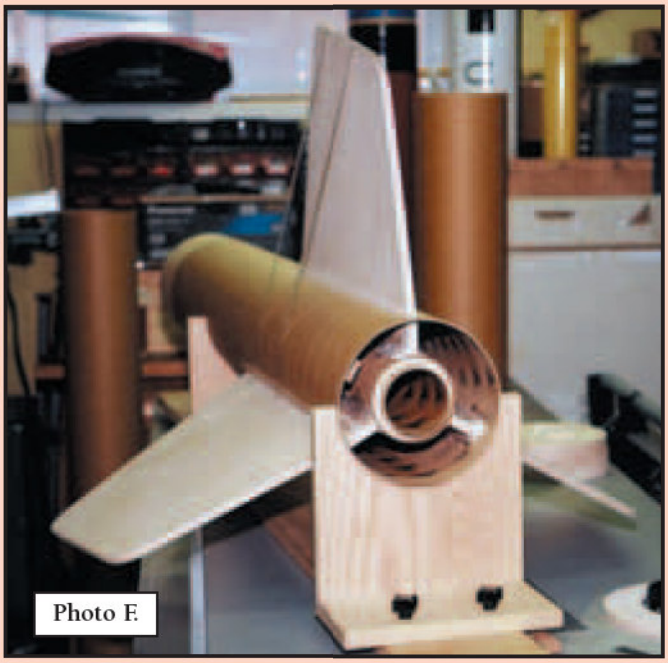


Photo F.

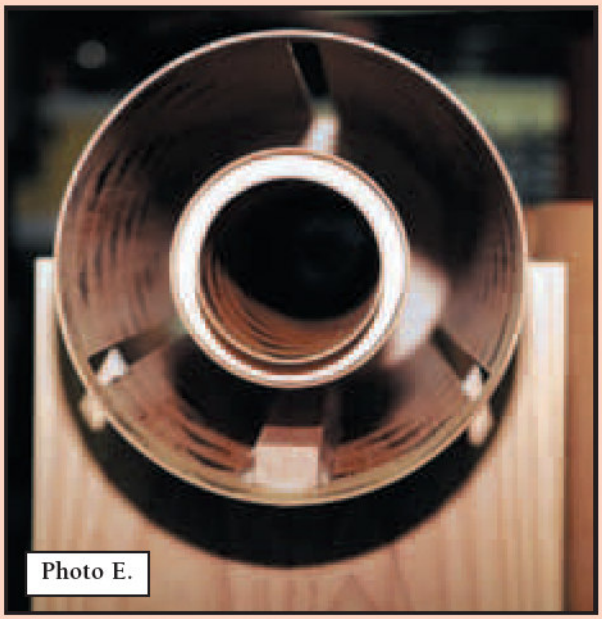


Photo E.

The fin attachment was next. I applied epoxy to the end of the fin tab, and then set the fin in place with tape until the epoxy cured. After all fins were attached, I then filleted every conceivable joint in the booster section. (Photo F.)

I filled the three airframe cavities between the fins with PML expanding foam. DO NOT use the canned foam from the home centers; it does not fully cure when used in large quantities, and it also requires air to cure. If you use it and it is not cured, the heat from the firing motor could and probably would ignite the uncured foam and destroy the rocket.

Next I laid the external fin fillets. There are many brands of epoxy on the market, but I swear by West Systems. It has incredible strength and I have never seen it fail—but the real secret for making fillets is to add a filler to the mixture. I add enough "404" high density filler to make a mayonnaise consistency. I then apply the epoxy with a popsicle stick and shape the fillet with a larger popsicle stick. I then carefully remove the excess epoxy with a razor blade, avoiding contact with the shaped fillet. When the epoxy becomes really stiff, I smooth and shape the epoxy fillets by dipping my finger in rubbing alcohol and running it over the fillets. (Photo G.)

Altimeter Bay

I started construction of my altimeter bay by beginning with a 12" phenolic coupler section. I then cut a 2" airframe section, and epoxied it dead center on the coupler. Next, I cut a 9" section of coupler material, then made a cut along the 9" length to split the section. This allowed me to "overlap" the coupler section to fit inside the 12" coupler section previously mentioned. After expanding the 9" section inside the 12" section, I was able to see how much material to remove to allow the 9" piece to be epoxied inside the 12" section. I then centered and epoxied the 9" section inside the 12" section. This allows 1-1/2" on each end of the 9" section.

As previously mentioned, the altimeter bay end plates were made from 3/4" Baltic Birch plywood. Upon deployment, these end plates on each side of the altimeter bay are what hold the entire aft and forward ends of the rocket together, and they undergo considerable stresses during deployment. I also made a "seal ring" for the forward end of the altimeter bay to seal the electronics from gases created from the black powder ejection charges. I cut the ring from 3/4" plywood, and then I cut a 3/16" deep by 1/4" wide rabbet into one of the face of the ring. This groove holds a 1/4" O-ring and allows it to

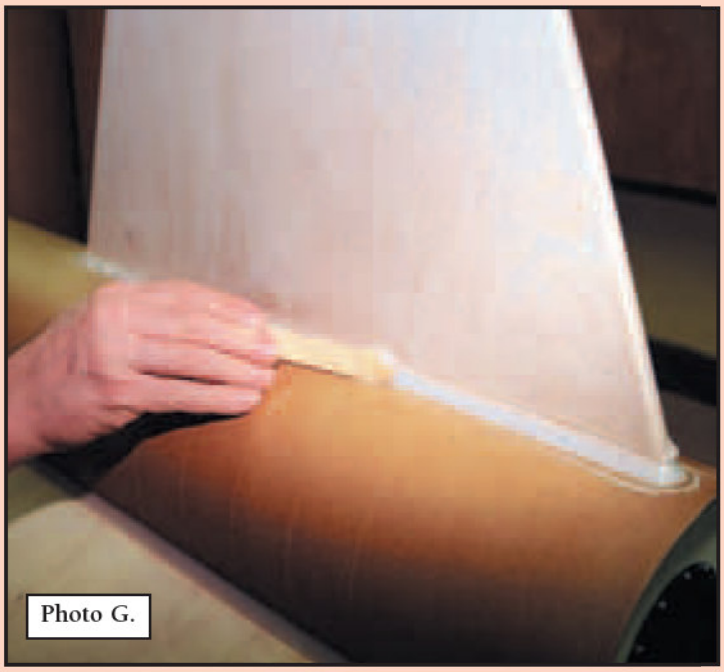
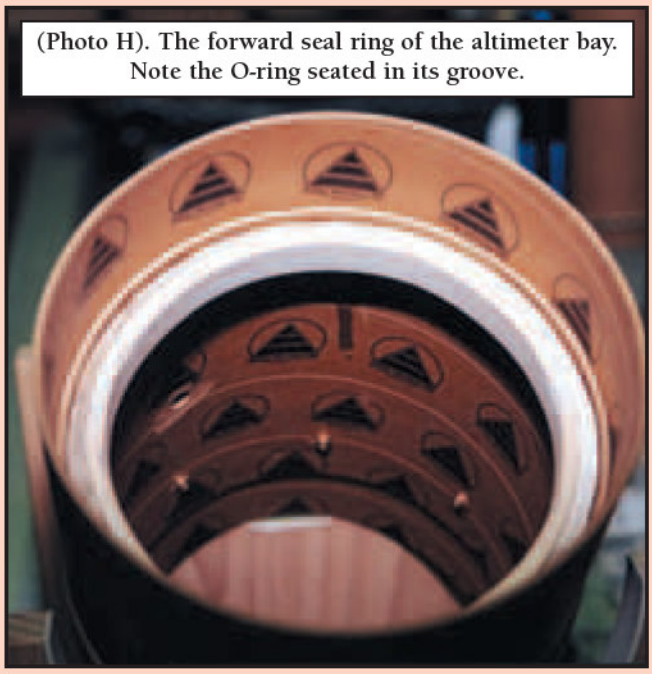


Photo G.



(Photo H). The forward seal ring of the altimeter bay. Note the O-ring seated in its groove.

sit 1/16" higher than the face of the plywood ring due to the 3/16" depth of cut. When the end plate is drawn tight against the seal ring upon closing the altimeter bay, the end plate compresses the O-ring and seals the altimeter bay. (Photo H.)

In order to fasten the aft and forward airframe sections to the altimeter bay, I elected to install threaded inserts into the altimeter section. I simply fitted the aft and forward airframe sections to the altimeter bay, and then drilled through the airframe sections and altimeter bay with a 1/16" drill bit to create marking holes. After removing the airframe sections, I drilled the altimeter bay marking holes with a 1/4" drill bit and installed 8/32 threaded inserts. The marking holes in the airframe sections were then drilled with a 3/16" bit to allow for the 8/32 screws. (Photo I.)

It would take many chapters to describe in detail how I constructed the entire internal assembly of the electronics bay. Carefully examine and study the photos (Photos J-M.) to understand how and what I did. The altimeter bay is con-

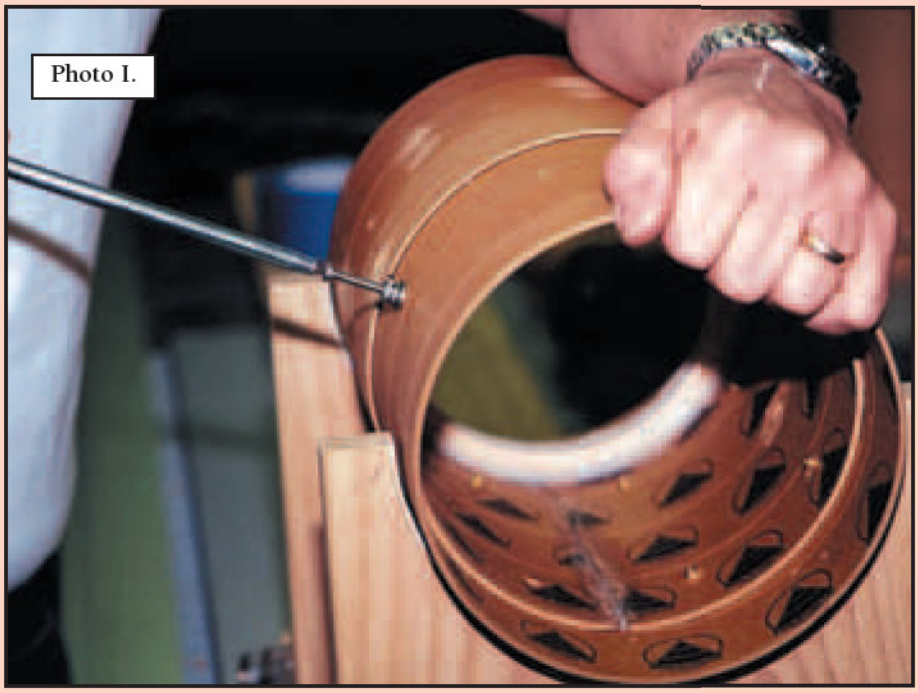


Photo I.

structed for dual deployment with redundant altimeters. The altimeter bay is held together by lengths of 3/8" all-thread. The electronics sled slides onto guides made of 1/4" all-thread. I used attachment plugs on the altimeter leads and on the end plates so the altimeter sled can be removed from the rocket. All my altimeter bays are made the same, so all I need to do is remove the entire universal electronics sled from one rocket and insert it into another.

After proper positioning of the altimeters, I drilled two 1/2" holes, 180 degrees apart, in the center of the 2" airframe section of the altimeter bay to allow for barometric pressure sampling. These holes also provide access to push-on/push-off switches on the electronics sled that activate the charges and the altimeters. The aft end plate was epoxied against the 9" inner section of the altimeter bay. The forward end plate is removable to access the electronics bay.

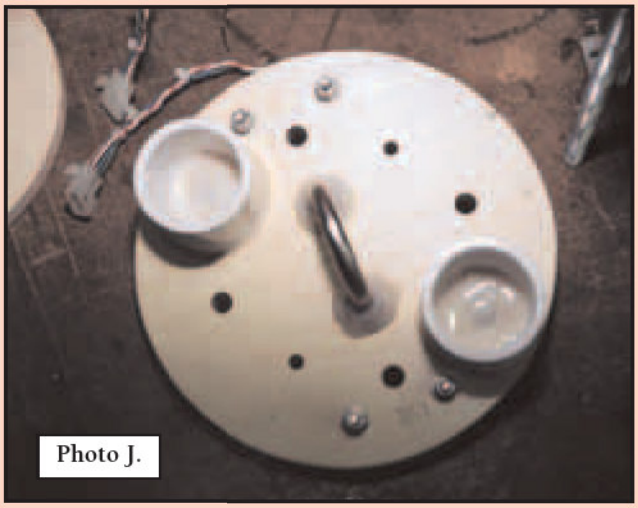


Photo J.

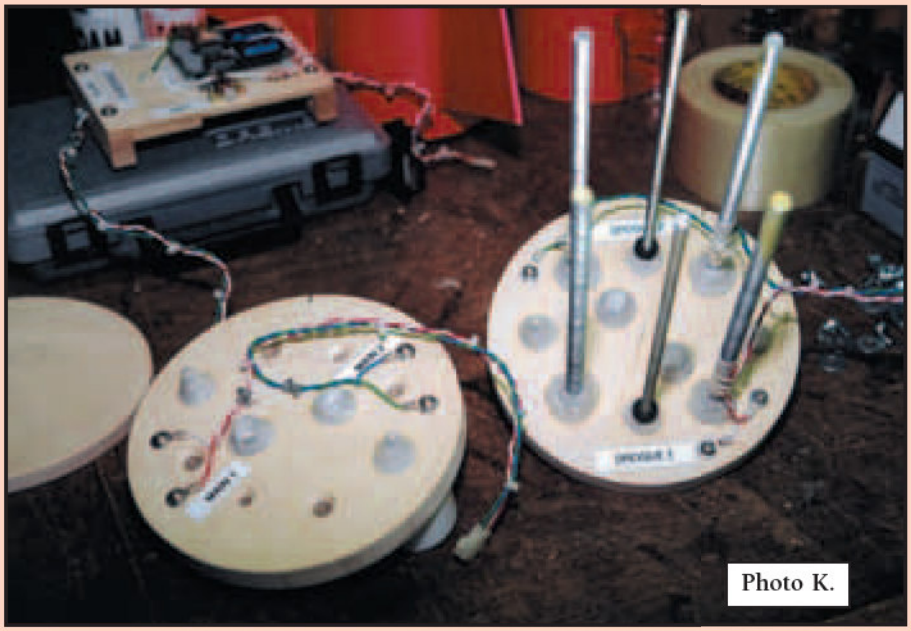


Photo K.

Airframe Assembly

At this point, construction progressed as it would have with any rocket. The entire rocket contains 6 sections. The booster section is 48" long. The drogue chute aft section is 24" long. The altimeter bay is 12" long, with a 2" centered section of airframe. The main chute forward section is 48" long. Another 24" section sits between the main chute forward section and the 30" nosecone. So the entire length of the rocket is 176", or 14 ft. 8 in. Using the multiplier I mentioned earlier for upscaling would have yielded a rocket approximately 4 ft. shorter, but I decided to "stretch" it so it would be bigger. There is no such thing as "too big a rocket"!

I "doubled-walled" the aft and forward airframe sections. I decided to epoxy coupler sections inside the aft and forward chute airframes to really strengthen them. My goal was to use enough black powder to create 15 psi for deployment. I know that is a generous amount of BP, and some of my acquaintances have questioned the use of that much BP—but the rocket *will* open! A little extra BP is a lot better that not enough. It can mean the difference between a successful flight and a rocket that "buys the farm." I also coated the inside of the airframes with epoxy to make the BP residue cleanup easier after a flight.

Since I decided to extend the length of the rocket, another very important factor came into play. When fully assembling the rocket with the simulated weight of an M2500GG motor and all components were ready for flight, the CG was 34" forward of the CP. Way too over-stable! I like a rocket's CG to be between 1 and 2 airframe diameters in front of the CP. I figure as the motor burns, the CG will move even more forward of the CP anyway.

So, I built the rocket contemplating this might happen with the CP/CG rela-

tionship. I already had 3/4" holes drilled through all the centering rings in the booster section for the possibility of adding weight to the top of the centering ring that sits at the forward end of the fins. I had to add 16 pounds of weight to the booster section to bring the CG back to 15 inches forward of the CP.

The final weight of the rocket with all components and motor came to 105 pounds. I spared no expense at making this rocket heavy. I like slow lift-offs because they are more realistic, and this rocket would definitely perform as such. Some of the contributing factors are as follows. The booster section alone weighs 45 pounds without a motor. The altimeter bay weighs 8 pounds. Now add 180' of 2" tubular nylon, a 22' diameter man-rated main parachute, 18 cans of Krylon spray paint, huge quick links, stainless steel nautical swivels—the list goes on—and you can see where the weight comes from.

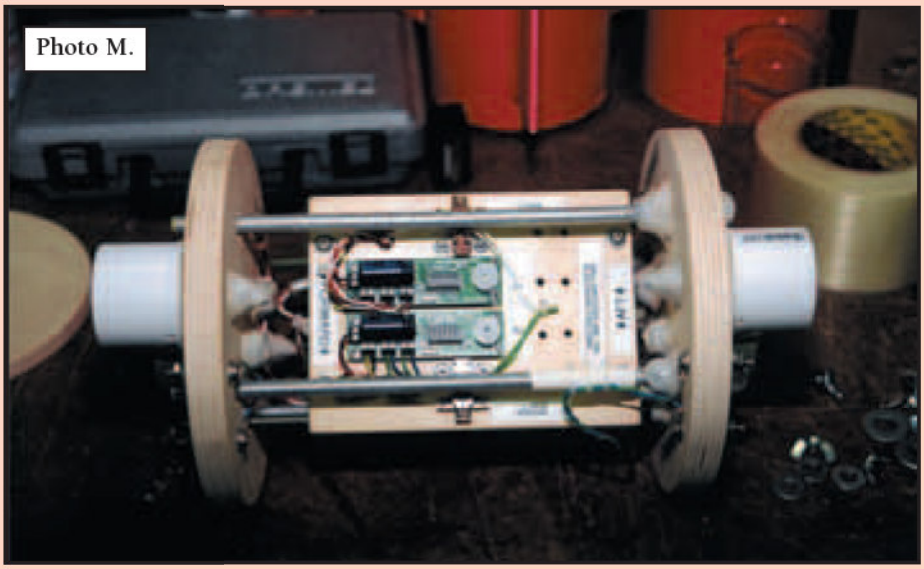


Photo M.

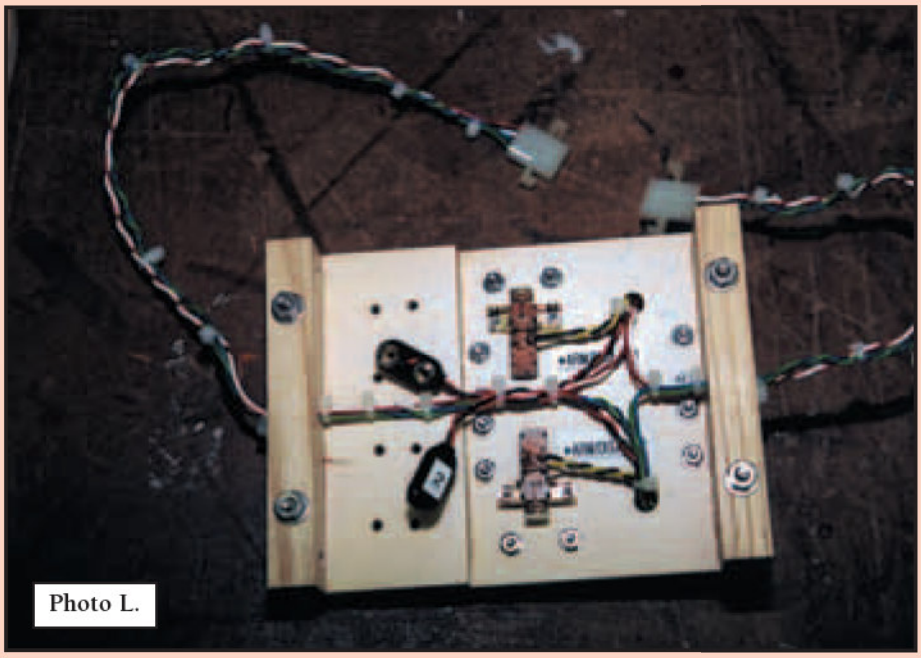


Photo L.

Anyway, the project turned out to be one massive rocket. I originally decided to use 5/16' Delrin rail buttons, but then I was told by Bobby B. from Hangar 11 that it would be advisable to use some massive rail buttons that he sells to fit "Unistrut" rail. So I decided to put 3 of those buttons on the rocket. Since this rocket was so long and heavy, the next problem was having a launch pad to support it. So I designed and, with the help of one of our club members, built a massive "Megapad." The pad weighs over 500 pounds and its massive support legs stretch almost 25' across. I used two 10' ladder tower sections with 20' of Unistrut bolted to the

tower supports. The entire tower hinges down to allow easy access to load the rocket.

Launch Day

Our club, NAR Section #614 NEPRA (www.nepra.com), launches every second Saturday of the month from April to November. July 10, 2004, was the day the rocket would have its initial flight. After prepping the rocket and assembling the AMW M2500GG motor, I was ready to make the 500' walk out to the away cell. As with all monster rockets, it took several of our members to carry, load, and get this rocket vertical on the launch pad.

I used two Magnelite pyrogen dipped igniters taped to an 1/8" wooden dowel to get the igniters way up into the M2500GG. After arming both Perfectflite altimeters, I attached the igniter wires to the launch leads.

Our LCO gave the 5-second countdown, and when the button was pushed, the M2500GG instantly came up to thrust. Without any effort, the rocket roared off the launch pad and quickly gained altitude.

At apogee, the Rocketman ballistic drogue chute was deployed by 6.5 grams of BP. As the Cherokee-M descended, the 22' main was deployed perfectly at 1100 feet by 13 grams of BP.

The main was more parachute than this rocket needed, but I always "over-

chute" my rockets. I prefer them to land like a feather instead of smacking the ground, and then having to repair broken pieces. The Cherokee-M flew to 3201 feet and landed approximately 300 yards from the launch pad, and sustained absolutely no damage.

In summary, it took exactly six months from the start of construction of the rocket and megapad, to the initial flight. My rocketry endeavors would not be possible and enjoyable without the support of my wife Lori and my son Andrew. They both have been major assets to my projects. And my extended thanks to Ed Sopinski, Eric Salerno, Kevin Salerno, Tim Seamans, Walt Noreika, Brad Snyder, Dustin Day, Joe Pidich, Bob Theobold, and Ron Hungarter, members of NEPRA—without their help, this flight would not have been possible.