Half Scale H

Group Project Idea

Our rocketry club, Tripoli Ft. Wayne Prefect #104 / Summit City Aerospace Modelers NAR Section 282, in Northern Indiana doesn't have a lot of members, but we do have diversity. Young and old, men and women, boys and girls, experienced and novice rocketeers. Some are well versed in high power, other are embedded in model rocketry. Across the group, most of the concepts of rocketry have been mastered by one or more members. With this mixture, we had the perfect makings of a group project. The best part of a group project is the concept that one can contribute his or her area of expertise while learning on other areas. With our group project, some of the participants wanted to be involved in a really big rocket, others wanted to get hands on experience with fiberglassing, some were looking to do clustering, and still others wanted to see up close how electronics were done. Our project goal was to provide all this to the young and old, experienced and novice, and to have a good time while doing it.

How It All Started

In September of 2000, our club co-sponsored a high-power launch South of Indianapolis at the Johnson County Park. Pretty much across the road was Camp Atterbury, a large military training base. Out front of one of the base entrance gates, an Honest John missile with its launch vehicle was on display. Several of the launch attendees had seen the missile, and one member, Dennis Watkins, with tape measure in hand went to go check it out. Now as a side

Honest John

BY MIKE LAW & DENNIS WATKINS

note, if you decide to stop at a military base to check out a display, it would be worth your while to ask a gate guard where you can park. If you see Dennis, ask him how it feels to be approached by some Military Police vehicles with their lights flashing while you have rocket motors in a magazine and a few rockets in the back of your vehicle! Dennis figured he would just pull into the drive and let the boys out to run over and take measurements of the missile while he stayed in the vehicle.

The Design Meetings and Prototype

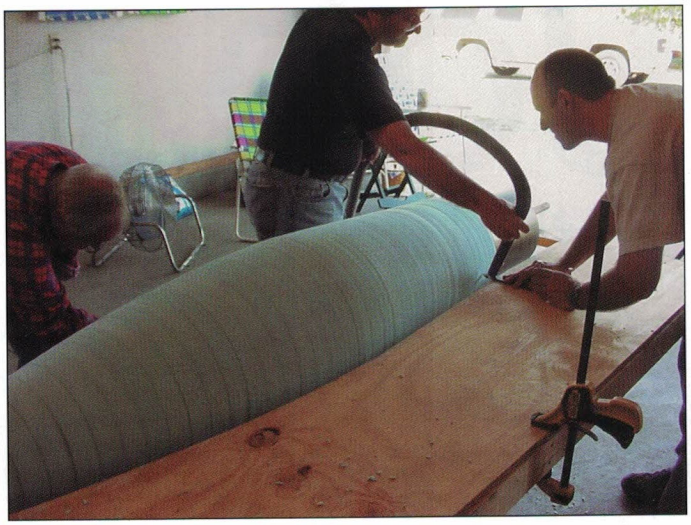
For several weeks after the Johnson County Park launch, Dennis and I traded thoughts and rough designs on a group project of a FULL Scale Honest John. The project seemed on the very large size, but possible. We also threw around the thought and some designs on a half scale version. After we worked out some of the overall design pieces, Dennis and I proposed the idea of the full-scale project to the club. Because of the size and probability that the motor class would be in the "O" range, the project seemed to be too big for the club to bite off at that time. It was suggested by a club member that a half scale project would be more appropriate. We already had the rough design. We knew it could be done well with certified motors. So, in a moment of sanity, we decided to go with the half scale version. Shortly after that meeting, we had seven members commit to the project; Joe Isca, Mike Law, Charlie Humphries, Greg LaMaster, Mark Rogers, Dennis Watkins, and Dave Wyss. Along with these members, many youth and teen members were involved. We had ourselves a project.

The group began meeting on a monthly basis to put our design thoughts together and begin some of the basic building tasks. At our annual Christmas party, a rough prototype of the fin can capable of removable fins was presented and agreed upon. It was quickly apparent that with meeting at a rate of once a month, it would take forever to complete the rocket. So, the group picked up the pace, gathering every other week and for a while once a week to work as a group. This was quite a commitment for the group, considering that some of the group had a ways to travel, like Mark Rogers with a two-hour drive each way. To save time, several of the tasks were assigned to members to work on between group meetings, the fins, fin-can, nose cone, and electronics bay. The final design called for a 53% scale to fit 12" tubing. A cluster arrangement of a single core 98mm motor with four 75mm outboard motors would be used with all motors being lit at once. The worry of power load transfer through the airframe was solved by providing reinforcement measures all the way from the motor thrust plate up through the electronics bay, freeing the outer skin from this task. The rocket would use dual deployment with triple redundant electronics. Due to the large nose size of the Honest John, at main deployment, the main body and booster/fin-can would separate from the nose and each would descend on their own chutes. The projected launch weight would be 135 pounds with the preferred motor combination of a core M-1939 and 4 K-560s.

Construction

The main tubing was made from 12" Sonotubes. Each tube was to receive a layer of 10oz, 6oz, and 3oz cloth. First, the paper skin was peeled off and the tubes sanded. Then the 10oz. and 6oz. layers were applied. After sanding with both layers applied, it was apparent that the final layer of 3oz was not needed in order to provide a nice finish and the tubes were certainly strong enough. The couplers and altimeter bay were created by cutting a sliver out of the 12" Sonotubes, reconnecting them, and applying a layer of 10oz cloth on both the inside and outside of the coupler. This made the couplers the correct diameter and unbelievably strong. A layer of 3oz. cloth was put on to give the outside a smoother texture for sliding into the body tubes. Some minor sanding was all that was required to provide the perfect fit.

The fin can was created with _" upper and lower



plates on the 98mm motor tube. Fin slots were made from _", 9ply Birch with _" solid butt strips on the 98mm motor tube. The slots were tied to the upper and lower plates by dowels and to the adjacent slot with a _" ring half way up the can. All joints were fiberglass reinforced and filleted. The fins are _", 9ply Birch with several areas removed to reduce weight, leaving structural supports in place. These voids were filled in with blue foam, then a complete layer of blue foam on each side of the fin. A jig was created to provide a guide to sand the outer layer and create the correct airfoil on each fin. The first fin was sanded by hand with bar sanders. Even with two people, this seemed to take forever! An annual hobby show was just around the corner, and the team wanted to put the work completed on display for the public to see. Dennis worked on the fins all day and night and realized that with hand sanding, they would not be sanded in time for the show. So a sanding bar was modified to fit a finishing sander, and the "Tim Taylor Bar Sander" was created to do the job. The work was put on display at the show and drew quite a bit of attention. Next, the fins received two layers each of 6oz and 3oz glass. The result, a removable, airfoiled fin that was light, yet so strong that it wouldn't flex under high stress. To ensure that the outer skin would not flex under thrust, Greg LaMaster provided the idea of a single coupler reinforced with vertical struts and the lower portion of the outer skin attached bolted atop the fin can. The electronics bay mated with this coupler and provided a continuous internal column of strength for the lower and middle outer tubes.

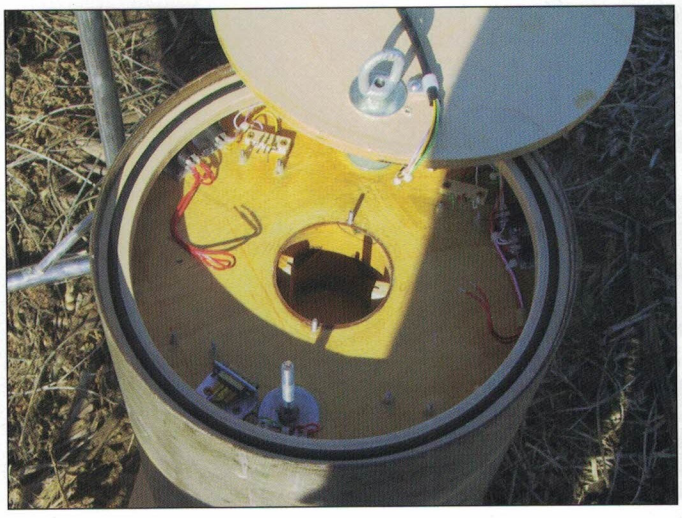
Now it was time to start the nose cone. How to do this was a job in its own. At 6.5' and 16" in diameter, this was no small task. As we would use blue foam to make the shape, it was decided that an internal structure was needed to perform several functions. Those being to provide space for ballast if needed, extra room for recovery hardware, and a shoulder to support the nose cone on the payload tubes. To create the base of the internal structure, a main coupler was used with a length of body tube epoxied in place to make the shoulder. Then a length 8" Sonotube with two centering rings were glued inside the base, creating the ballast area and additional recovery area. Between the two centering rings, four 5/16" threaded rods were run which were coupled to 2 5/16" u-bolts. These were to be the hard points for the recovery system. At the forward end of the 8" tube, two centering rings were fitted to hold a 1.25" dowel that would run to the tip of the nose. The dowel would provide support for the blue foam and act as half of the shaft for turning the cone. A matching plug was made to fit the lower end and complete the turning support. Blue foam rings were drawn and cut to fit the dowel and tube internal structure and the approximate outer dimension. All the rings were epoxied to the internal structure and allowed to fully cure. A temporary lathe was made using sawhorses, bearing blocks, and an old motor to drive it. VCP was used to create a template of the nose cone shape. This was glued on to a sheet of plywood, the shape was cut, and the sheet attached to a framework on the sawhorses to make a pattern to follow while turning the nose. Tools were formed to ride the template, taking the guesswork out of the cuts. We started out a ways and with each pass, moved the template closer to the final size and shape. As we turned the nose, shop vacs

were employed to keep the mess to a minimum. All went well until we got close to the final shape when we picked up a vibration. We then switched to gluing sandpaper onto the template edge and turning the nose by hand, slowly moving the template in until we had the final shape. With the turning complete, we just had to assemble it to see what it looked like. Needless to say, we finally began to realize just how big our project was going to be. It was finally beginning to look like a rocket.

It was at this point that the project had a set back. Mike Law and his wife Valerie, expecting their third child, received notice that there was a problem. It was going to take some medical specialty and a miracle for all to come out well. The project was shelved for this important event. As the members prayed for Mike and his family, we hoped for the best. In May, Seana was born and miracles happened. Now we have the newest member of the club and this project. May we all be blessed to live long enough to witness one of God's miracles happen as we have.

It was not until late June before we got started on the project again. With the nosecone turned, it was now time to glass it. The lower conical section could be glassed with one piece of glass, but the upper Ogive section would take four sections. This was done over four separate days, using two layers each of 6oz. and 3oz. cloth. When complete, the nose was held up and using a table belt sander, the wooded rod was brought to a point matching the rest of the nose. The tip was then glassed to provide a better finishing surface. We had no specifications for the spinjets, so we did our best to simulate them. Blue foam blocks were cut to the appropriate shape and hand sanded against sandpaper affixed to the nose in the proper positions. These were then epoxied in place and glassed over.

As we had our own Electrical Engineer on the team, Charlie Humphries, we assigned the electronics bay to him. The electronics decided for the project were two Missile Works RRC2 Recovery Controllers and an Olsen FCP-M2 Altimeter. The RRC2 units were to be set for 1,000' and 800' main deployment, while the Olsen FCP-M2 was to be set for delayed apogee and 1,500' main deployment. He ran several ideas past the team on how to do the bay. The problem being that with a bay that's 12" dia. by 23" long, the vent holes for the electronics would be enormous. Charlie ran figures for a three-sided, four-sided, and even a six-sided internal block to provide mounting and reduce internal volume. Even with this much internal reduced space, vent holes almost _" would still be required. So, Charlie came up with a brilliant idea. Put in a bulkhead to mount the electronics that only used 1.5" of the bay. Jim Amos from Missile Works was consulted on a few details of the Recovery Controllers mounting and functioning together on a single apogee charge. Jim informed us that the RRC2 units could be mounted horizontally. However, the Olsen unit having a G switch had to be mounted in a vertical position. A small section of tubing was mounted in the middle with rails for the Olsen unit to slide into. A lid with vents to allow for equalizing pressures and the Olsen unit was set. The rest of the space in the bay would be used for future enhancements, such as video or camera equipment. Six of the new Missile Works switches put in pairs, 120 degrees apart, were used for shorting the charges and arming the electronics. The amazing part was that the _" holes used



for access to the switches was all that was necessary to vent the bay. Great job, Charlie!

Work on the project picked up pace the closer the flying season came. Several minor details needed to be addressed rather soon, such as motors and a launch pad. Launching a bird of this scale usually falls outside of most of the team member's hobby allowances. What was needed was a sponsor. Ross Dunton from Magnum Rockets was approached and sponsored a good portion of the motor expense. Ross also helped out with some of the needed motor casings. With the club's casing and Ross's casings, we were still short two 75mm 2560 casings. Jim Januzzo and John Lyndgal answered the call and provided the use of their casings for the flight. For the pad, the team had a pad design in mind, two sections of Unistrut donated by a local electrician, and antenna parts for the tower donated by Dan Troxell. But, time was getting short. Our club had a brand new member, Tim Howe, who just happened to be an experienced metal worker. We passed the idea by Tim and he, along with his brother, agreed to build us a pad that would handle the project at little to no cost to the team; fantastic!

The HJ was close enough now that we needed to start looking at scheduled launches and inquiring to Launch Directors on accommodating this size of rocket (cluster of one M and four full K motors) at their launches. Our original thought was to take the HJ to NARAM in New York. We contacted the NY crowd and thought we had a go. As they looked into it, they determined their field would not handle a cluster of this size safely. One of our project requirements was that the first launch had to be close enough to allow all of the members to be present and help with the launch. This ruled out the other national launches occurring out West. After checking into a few possibilities, it was decided that the Danville 2001 (October 20 & 21) launch held by Tripoli Central Illinois was our best shot. They have a beautiful launch site and even though they are a small club like ours, they were more than willing to accommodate our project. The details were worked out with Gary Buck and Don Reasor of TCI and we were set. With Danville a go, we had two months to get the Honest John ready. The rush was on, working every weekend and sometimes both days with as many members that could show up. When the 9-11 terrorist attack occurred, the Danville waiver was rejected. Everyone understood the issue, but continued to work on the final details of our

project. When we got the word that the Danville waiver was granted, the rush was on to complete our project. The group was proud enough of the project that we had shirts ordered and embroidered with our project and names.

With the major components now complete, it was time to test the ejection charges. First, a series of tests to check the circuits and electronics, then tests to verify the determined amount of ejection charge. The debate in this was how big of a charge was needed to pressurize the tube to 10psi. At first, it was thought that 10 grams of BP would be the right amount. Was this enough or too much? The 12" bulkheads represent about 113 sq. in. or 1130 lbs of force at 10psi. Something about this didn't sound right. We decided to work the charge down to 7.5psi for the first test with 8 grams of powder. Well to say this was more than what was needed is an understatement. This works out to over 800lbs of force. The fin can was weighted to simulate the loaded weight with fins and wrapped in quilts to help soften the landing, and the rocket assembled without the fins or nose. The assembled section was propped against Mike's tractor and Dave Wyss volunteered to steady the tube. When we set this off, not only did it sound like thunder, but it kicked the fin can about 20' down the yard, and moved Mike's 800lb John Deere 9" sideways! It was decided to back down the apogee charge to 7 grams, but leave the main charge at 9 grams because we were bringing down the nose separately.

It was now time for the finishing work. Sand and prime, sand and prime, sand and prime! Never knew we could get so up close and personal with a rocket. After about two weeks of work, it was ready to paint. Early on, we had decided on a testing roll pattern shown on the Redstone Arsenal web site. Lucky for us the Honest John and the pattern we chose was featured in the Jan/Feb 2001 issue of *Sport Rocketry*. The dimensions in the article were invaluable in doing the paint job. With the size of this rocket, it was decided to go with automotive paint. A trip to Automotive Hardware in Ft. Wayne Indiana, and we had our base and clear coat paint. The base coat of white was applied and the roll pattern laid out. Laying out the roll pattern was a slow and arduous task; however, the results were worth the effort. Clear coat was then applied over all areas. The US ARMY decals were applied, and as Ross Dunton had come on as our major sponsor, his WWW.MAGNUMROCKETS.COM sticker was applied. The rocket was nearly ready to go.

All had come together just as we had envisioned. Believe it or not we weighed what we thought it would per RockSim, 135lbs, and our CG was within 1" of predicted with no weight added to the nose. Around this time, Joe Isca contacted both the local newspapers about the project. Both papers decided to do articles on the project and the group was interviewed. The Honest John was displayed at two of our local launches, one at which photographs were taken for the papers. Both papers printed very favorable articles on the project just before the trip to Danville.

The final few days before the launch were spent gathering and organizing all the parts and pieces needed for the trip, building a transport cradle to fit inside the trailer for the HJ, and testing the launch system. To improve the chance of all five motors lighting at once, the upper slug of each motor was painted with pyrogen and special electric match based igniters made. On Friday, several of the members gathered at the house to pack up the trailer, and then everyone headed over to Danville. Friday evening was spent making the motors and going over details.

Launch Day

Saturday morning was cool, crisp, and clear. We arrived at the launch site around 8:30am to find most of the team waiting and the usual large Danville crowd. After speaking with Gary Buck, the team began assembling the launch pad and system. The field was a bit soft, so everything was carried out to the designated location. After the pad was assembled, the HJ parts were unloaded and we began the assembly process. Many spectators and fellow flyers stopped by, watched, and inquired. One of the best features of our hobby is our openness and willingness to share information. The team welcomed people looking over our project and took the time to answer any questions that were asked. We knew the project was being followed online and got to meet a few of the followers, some of which came specifically to see the HJ and watch her fly. The HJ was transported out to the pad in two pieces. At the pad, the booster was loaded on the rail, the nose added, and shear pins installed in both the upper and lower separation points. Group photographs were taken, then the HJ was raised and more photos taken. Mike was told that by the time the HJ was ready to launch, he was looking pretty ragged and the photos show it. In the upright position, the HJ was armed and the area cleared while she was hooked up to the launch relay system. After a brief description of the project, the countdown was given and launch button pressed. The motors instantly came to life and the HJ left the pad, angled slightly after leaving the rail, then shot straight into the clear sky. The sound as she left the pad was incredible and we all cheered her on. She arced over and the apogee charge went off as planned. The R7 chute used as a drogue failed to catch air, either getting caught on something and tearing or scorched from the ejection charge despite using a deployment bag. At 1,500', the first main charge went off and the nose was deployed, pulling out the booster's 17' chute and its own R-16 chute as designed. Both chutes deployed perfectly and the HJ booster and nose descended nearly parallel to one another. Both pieces landed on the edge of an adjacent field. The team retrieved the pieces and gathered at

the trailer. With multiple electronics beeping, it was difficult to determine the reported altitude. At first, it was thought to be 5700'. But, after separating the electronics, it was determined to be 4500'. One of the four K560 outboards did not light, explaining the arcing leaving the rail and the lower than expected altitude. The igniter had fired and pyrogen on the upper slug burnt, but the motor did not completely light. The only damage to the HJ was minor scratches here and there and scorching of the bottom of the rocket. The team celebrated, began to relax, and get their individual projects ready to fly.

All in all, the project was a success and a fun learning experience for the group. Will we immediately start another project of this size? I think the group will take a year before starting another one. What's in store for the HJ? With any luck, look for her at LDRS XXI in Texas with a N2000 and four L850s.