

Drag of Nose Cones

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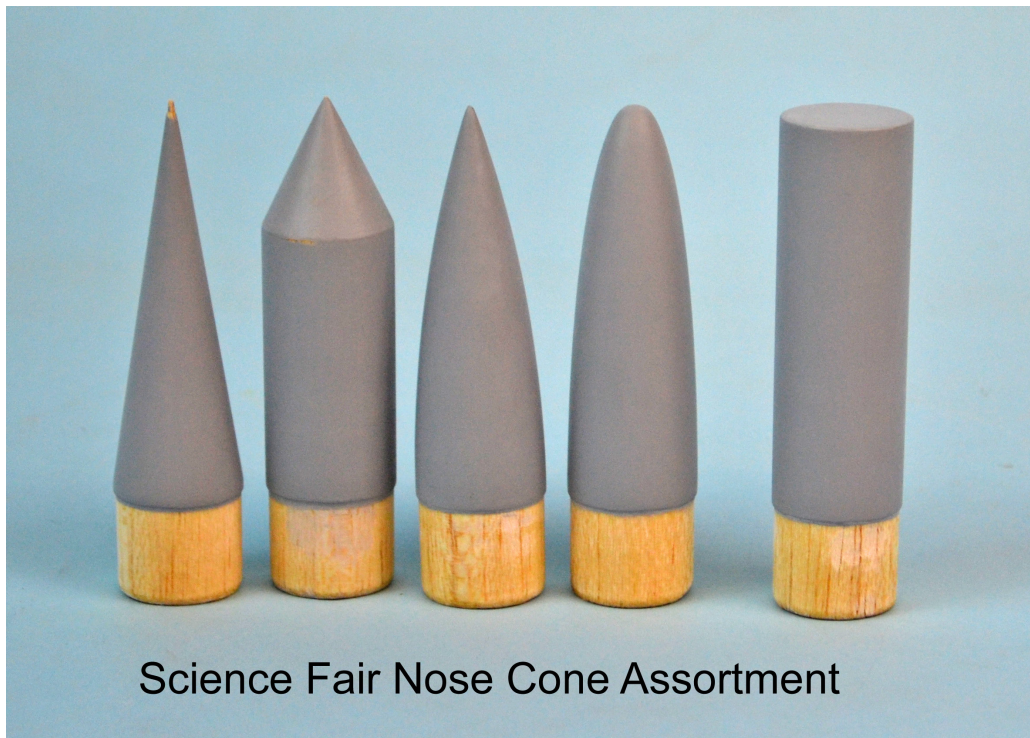
The Objectives Of The Work

My project was to find the best shape nose cone that had the lowest drag. This was done by measuring the force in a wind tunnel.

The Approach Taken

1. Where did I get the idea for my research project? I got my idea from my dad's book, "69 Simple Science Fair Protectors With Model Rockets" (page 92) which nose cones are the best?

2. Where did I get the nose cones? My dad made some of the nose cones. I got the rest from Apogee Components, at the Science Fair Collection (http://www.apogeerockets.com/Rocket_Kits/Skill_Level_1_Kits/Avion_Nose_Cone_Science_Fair_Kit) .

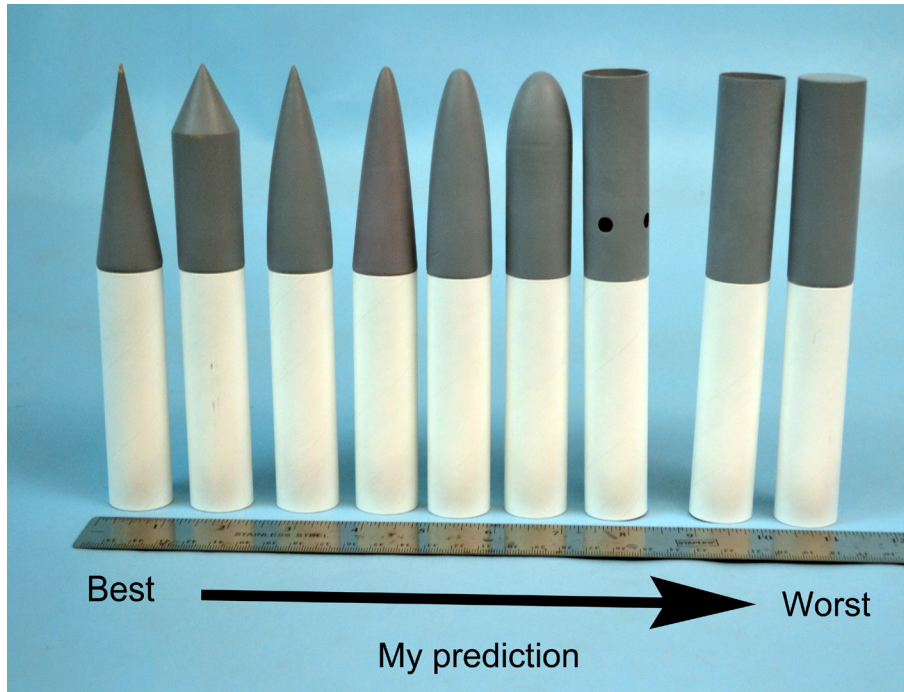


3. How did I make the nose cones? First I got the Science Fair Nose Cones. Then I lightly sanded them. Then I sealed them and sanded them to make them smooth. After that, I painted them gray and then I wet sanded them to make all of the nose cones the same smoothness. My dad helped me make the rest of them.

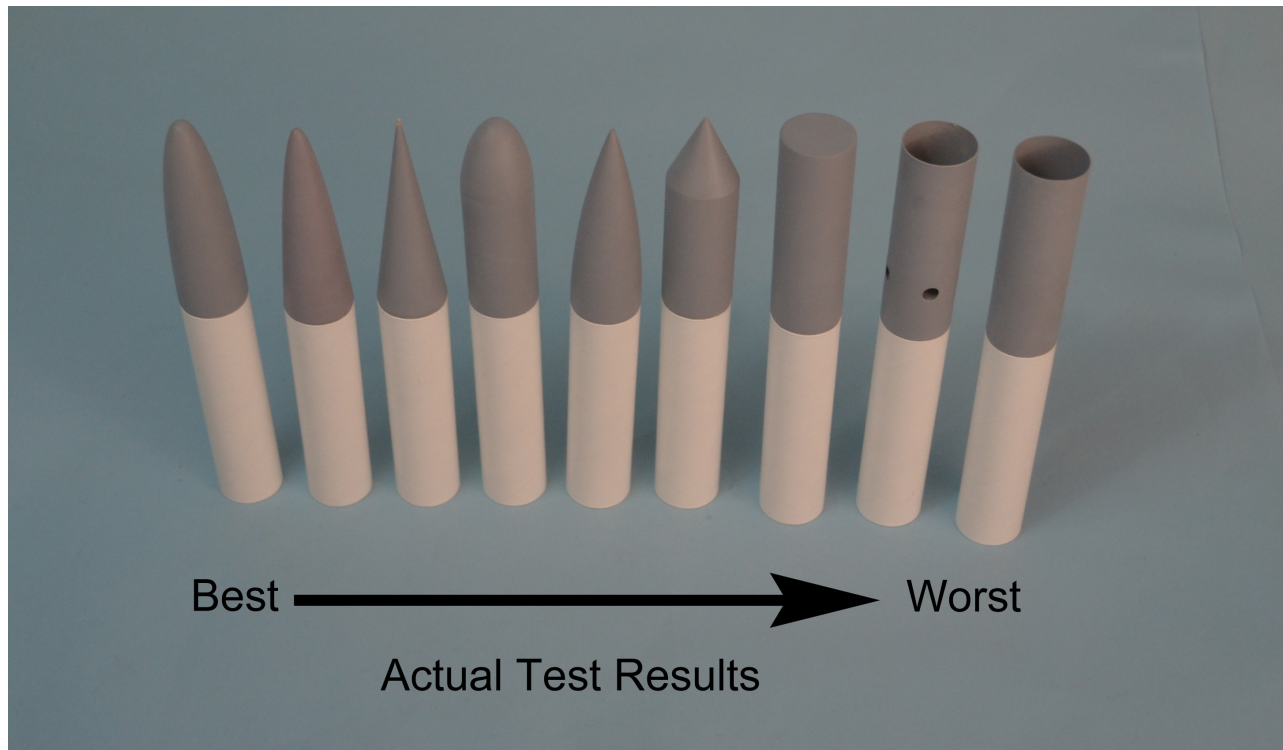
4. Then I went to the Air Force Academy to test them. The people there helped me with the wind tunnel and the measurements. We wrote down the data. It took 45 minutes to test all nine shapes.

5. When we got home we looked at the information. We wrote it down in our chart and my dad helped me make a graph showing how they compared.

6. Before I started I made predictions. The best one of my predictions was the Long Cone. The worst one of my predictions was the Solid Cylinder. Why? The solid cylinder is like if you stuck your hand out the car window with your palm facing the wind. The long cone is like if you stuck your hand out the car window with your palm facing down.



7. Which one was the best and which one was the worst? The best one was the Long Elliptical. The worst one was the Cupped Cylinder. I was wrong in my prediction.

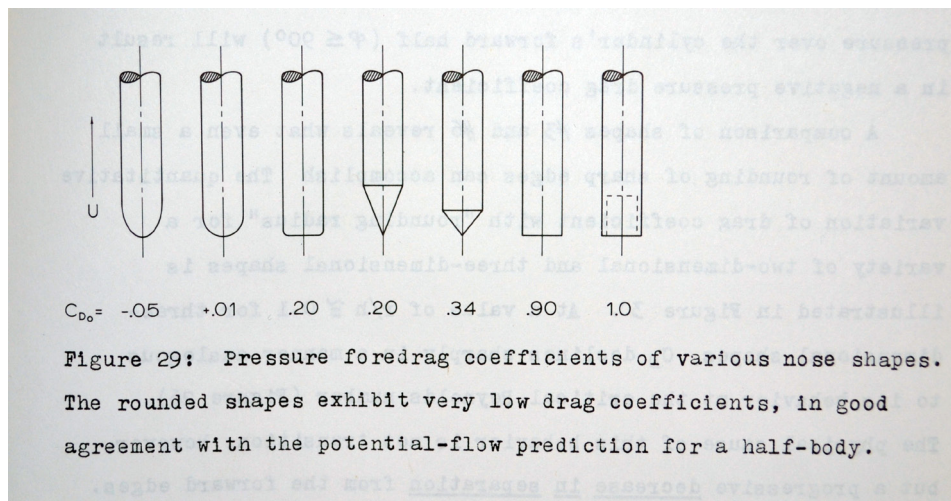


R & D Reports previously entered by the author, if any, with brief summaries.

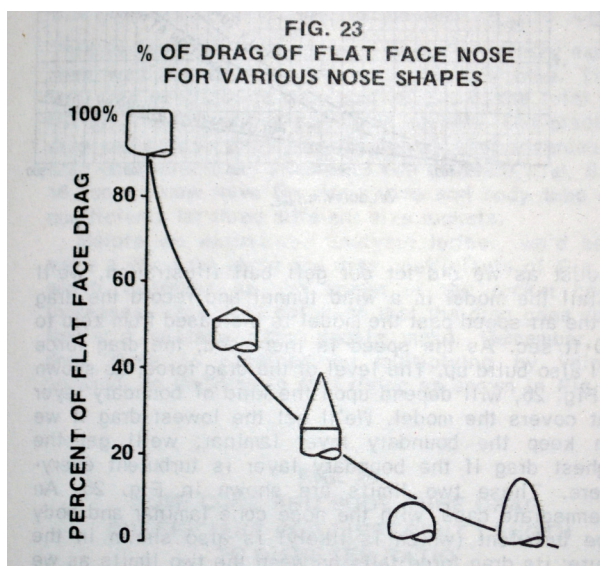
No R&D reports previously entered.

References to previous work done on the subject, found in research preparatory to this report:

The references that I found show that not everyone agrees which nose cones have less drag.



Above image from: *“Topics In Advanced Model Rocketry”* (page 381), by Gordon K. Mandell, George J. Caporaso, William P. Bengen.



Above image from: Estes Industries, *“TR-11 Aerodynamic Drag of Model Rockets”* (page 11) by Dr. Gerald M. Gregorek

The Equipment Used:

12" Wind Tunnels Open Circuit, Eiffel type (at the Air Force Academy).

The nine nose cones that I tested:

#1 – Parabolic, 2" long. Plastic – Apogee Components, PNC-24A



#2 – Ogive, 2" long, Balsa – Apogee Components Science Fair Nose Cone Assortment

#3 – Long Elliptical, 2" long, Balsa – Apogee Components Science Fair Nose Cone Assortment

#4 – Short Elliptical, 1-3/8th inch long, lengthened to 2" long with a body tube. Apogee Components VFNC-24B.



#5- Long Cone, 2" long, Balsa – Apogee Components Science Fair Nose Cone Assortment

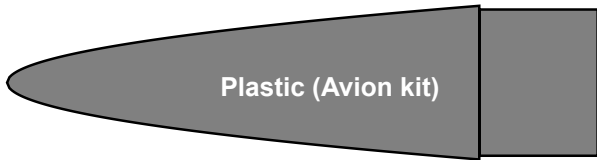
#6-Short Cone, 2" long, Balsa – Apogee Components Science Fair Nose Cone Assortment

#7-Solid Cylinder, long, Balsa – Apogee Components Science Fair Nose Cone Assortment

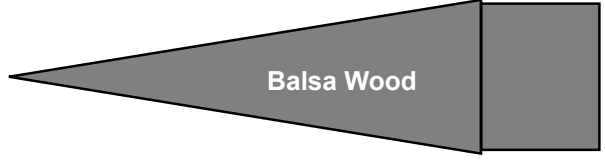
#8-Cupped Cylinder, Made from a 2" long BT-50 tube, with a tube coupler for the shoulder. The bottom of the cup is 1.5 inches from the top. It was made from a cardboard circle.

#9-Vented Cupped Cylinder, Made from a 2" long BT-50 tube, with a tube coupler for the shoulder.

Nose Cone Shapes Tested



Plastic (Avion kit)
Parabolic P/N 20000
PNC-24A



Long Cone P/N 19420
BNC-24-SF1



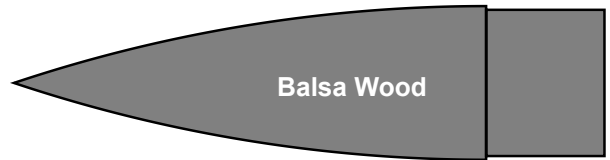
Long Elliptical P/N 19423
BNC-24-SF4



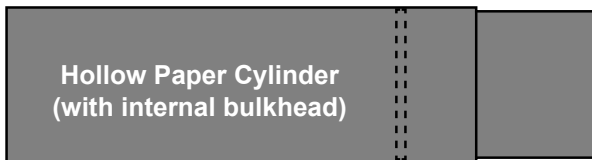
Short Cone P/N 19421
BNC-24-SF2



Cylinder P/N 19424
BNC-24-SF5



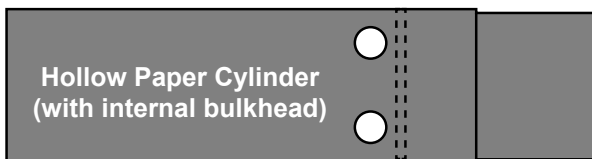
Ogive P/N 19422
BNC-24-SF3



Cupped Cylinder Home-made



Short Elliptical P/N 19997
VFNC-24B

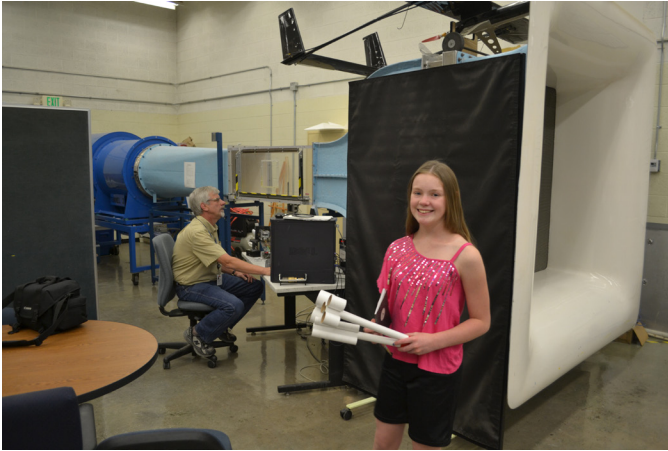


Cupped Cylinder With 4 Vent Holes Home-made

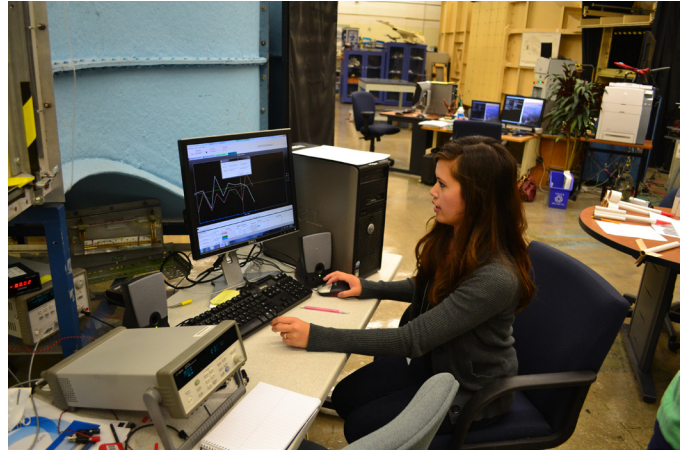
The bottom of the cup is 1.5 inches from the top. It was made from a cardboard circle. Four vents were made with a paper punch above the bottom of the cup.

The Facilities Used

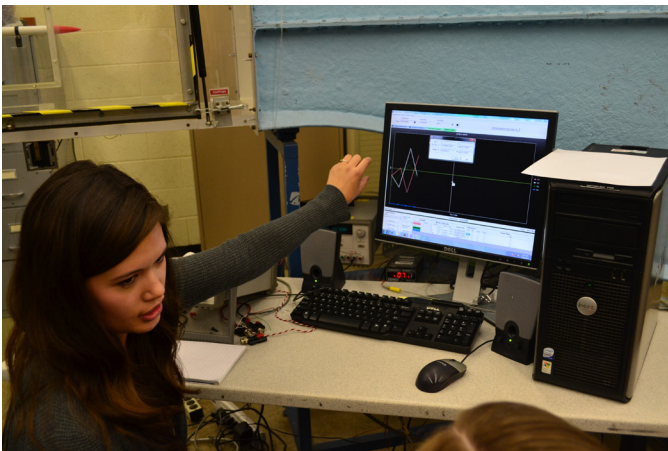
United States Air Force Academy Department of Aeronautics Laboratory



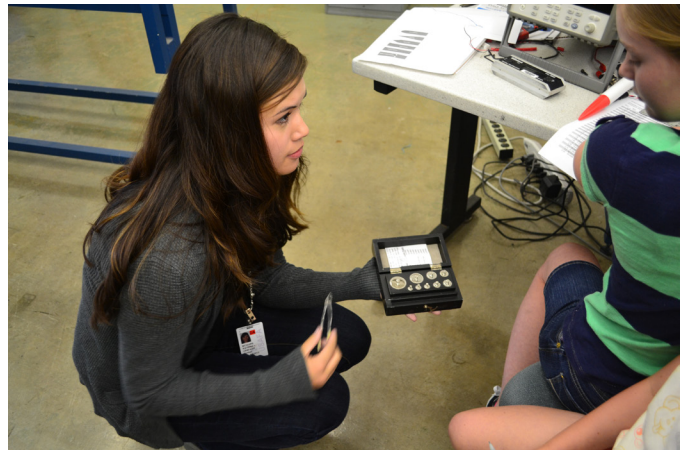
This is the wind tunnel that I used at the Air Force Academy. The man that keeps the tunnel working is Ken Ostasiewski.



Katrina McGuire helped run the wind tunnel for my nose cone project.



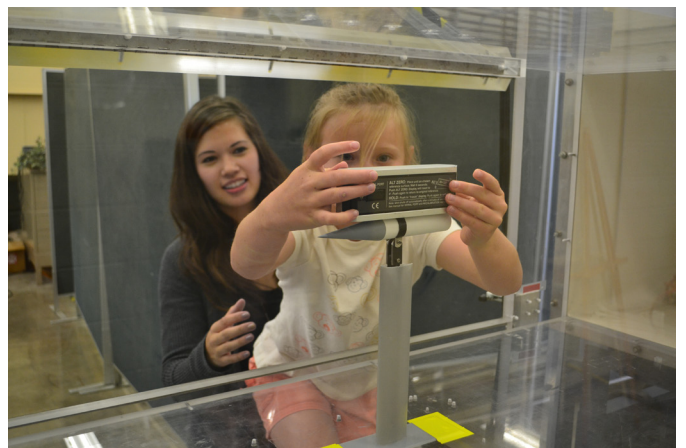
Katrina shows the computer at the wind tunnel.



Katrina shows the weights used to calibrate the system.



Katrina put the nose cones into the wind tunnel.



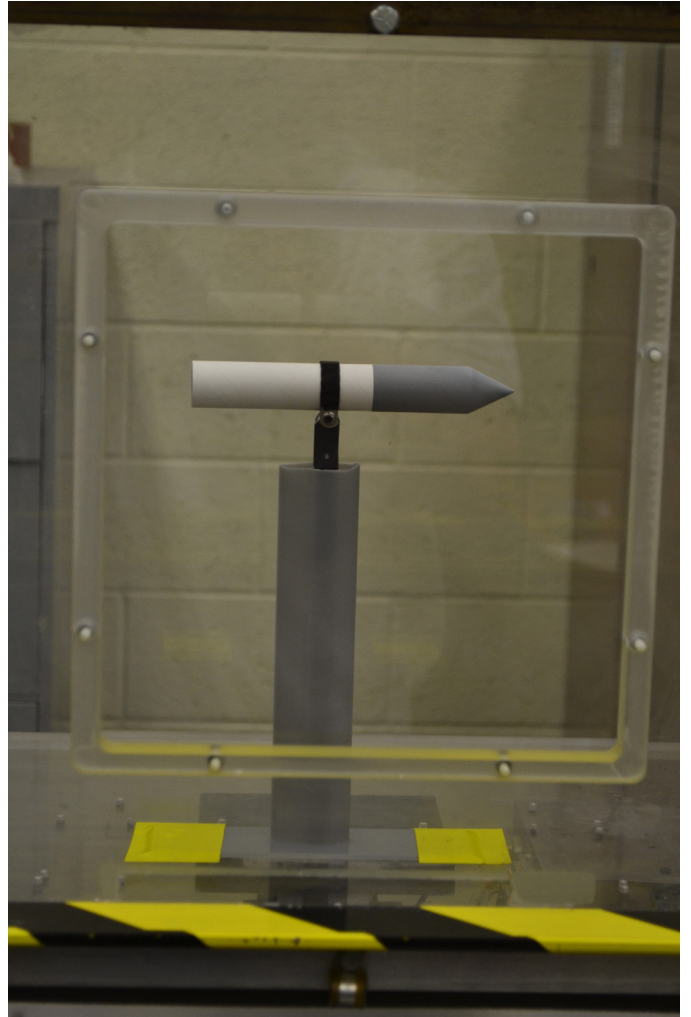
I used a level to make sure the nose cone was level.



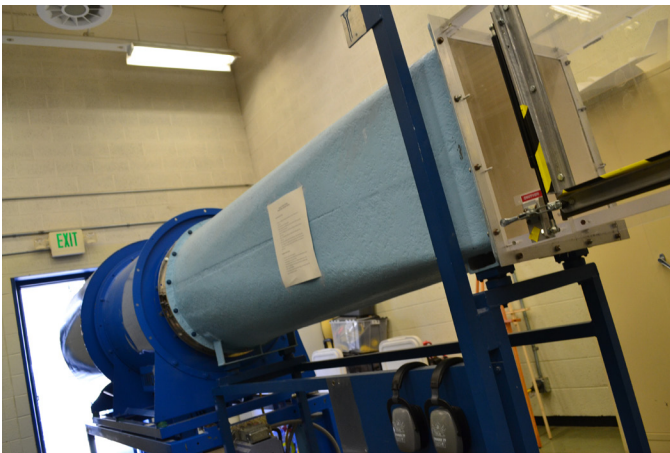
Levelling the nose cone.



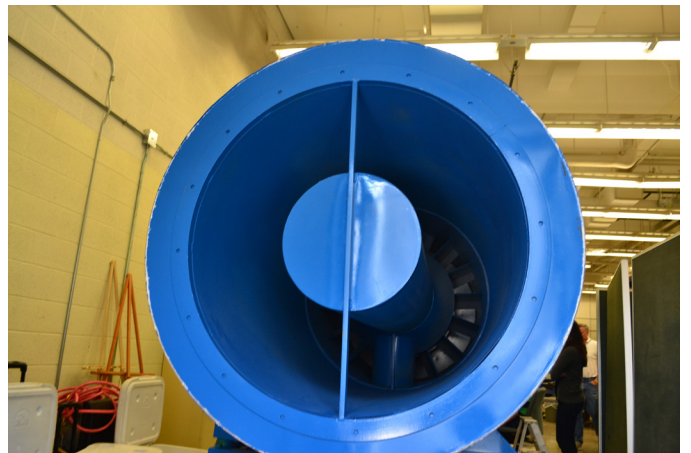
This is me writing down data



Nose cone mounted in the wind tunnel.



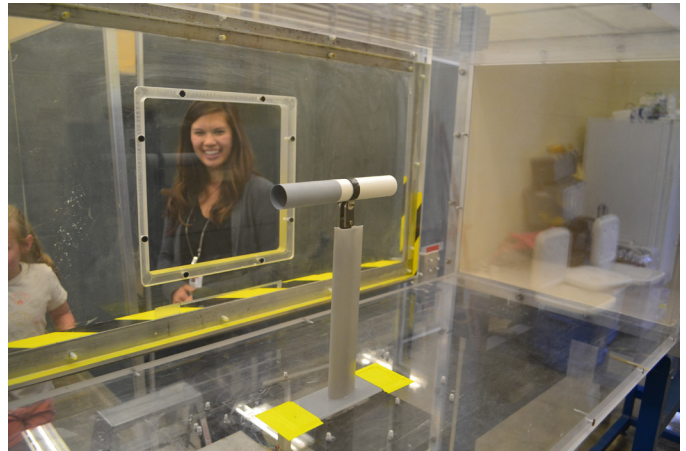
Picture of the wind tunnel.



The big fan in the wind tunnel.



Picture of the front of the wind tunnel where the air is sucked in.



The Cupped Cylinder inside the wind tunnel.



Mr. Christopher Seaver is the Deputy Director for Laboratory Operations in the Department of Aeronautics at the United States Air Force Academy, and gave us permission to use the low speed wind tunnel for my project and my sister's project.

The Money Spent on The Project (budget):

Apogee Components Science Fair Nose Cone Assortment = \$31.88

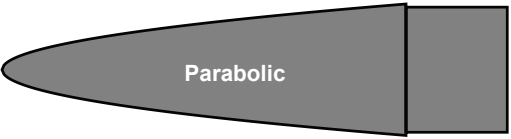
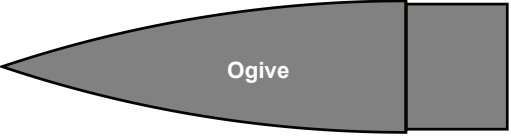

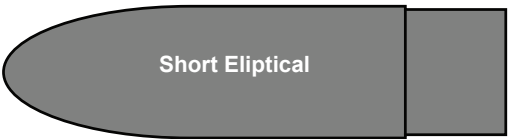
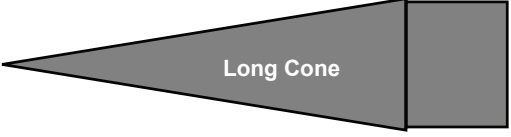
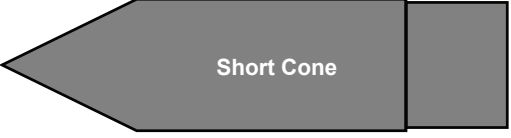

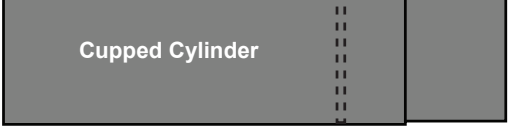
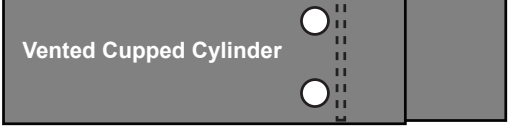
Body Tubes, tube couplers = \$10.00

Nose Cones = \$10.00

Total = \$51.88

The Data Collected:

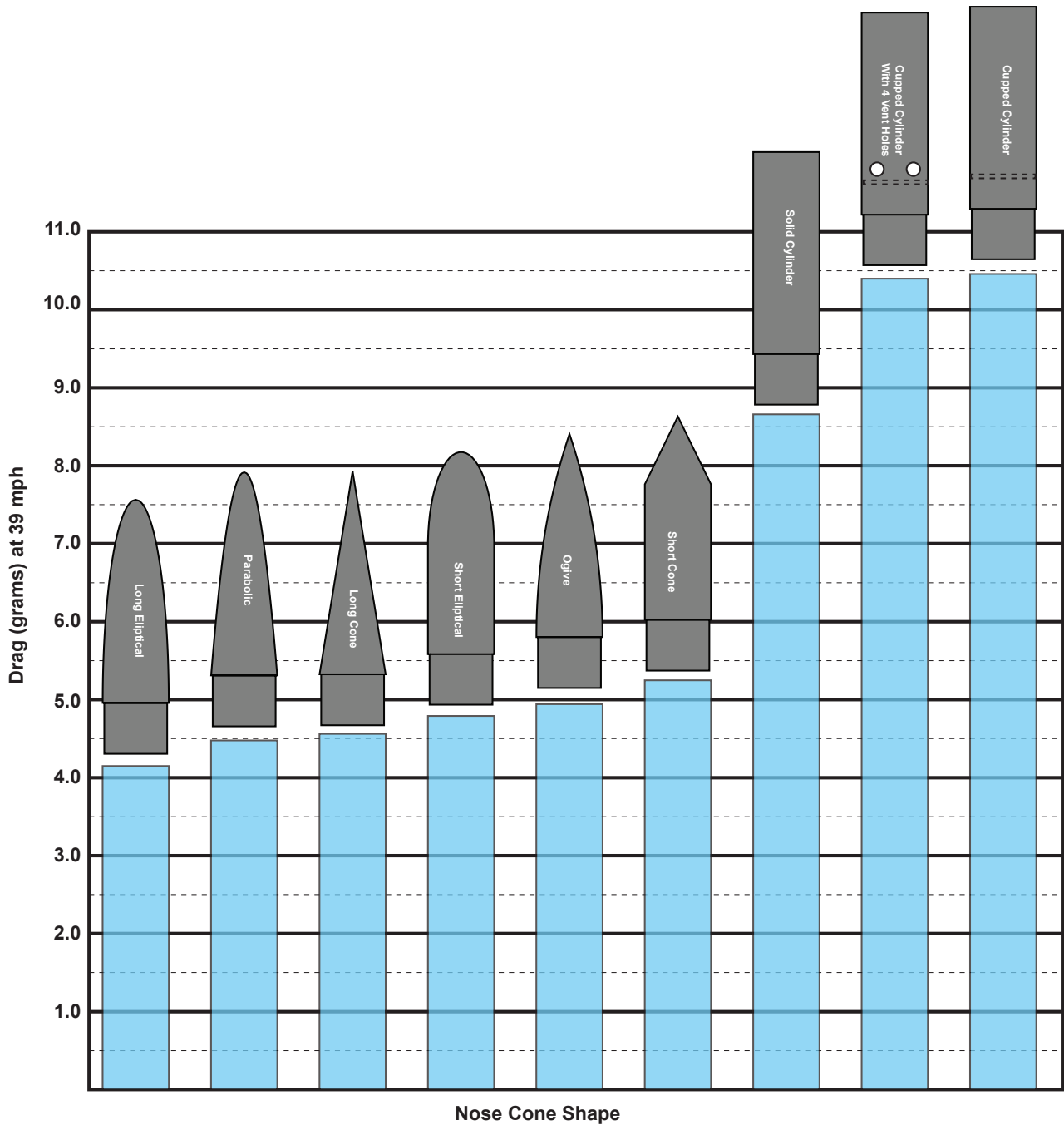
The chart on the next page shows the drag force for each nose cone we tested. This was the order they were tested in the wind tunnel.

Nose Shape	Wind Speed	Temp	Drag Force
 <p>Parabolic</p>	39.28 mph	72.0° F	4.477 g
 <p>Ogive</p>	39.28 mph	72.0° F	4.942 g
 <p>Long Elliptical</p>	39.27 mph	72.0° F	4.149 g
 <p>Short Elliptical</p>	39.27 mph	72.0° F	4.791 g
 <p>Long Cone</p>	39.26 mph	72.5° F	4.561 g
 <p>Short Cone</p>	39.25 mph	72.0° F	5.248 g
 <p>Solid Cylinder</p>	39.24 mph	72.0° F	8.659 g
 <p>Cupped Cylinder</p>	39.26 mph	72.0° F	10.459 g
 <p>Vented Cupped Cylinder</p>	39.19 mph	72.5° F	10.399 g

The Results Obtained:

Heres the list of nose cones from best to worst:

- #1 - Long Elliptical
- #2 - Parabolic
- #3 - Long Cone
- #4 - Short Elliptical
- #5 - Ogive
- #6 - Short Cone
- #7 - Solid Cylinder
- #8 - Vented Cupped Cylinder
- #9 - Cupped Cylinder



The Conclusions Drawn

The conclusion drawn, if you want your rocket to go high you should use the best nose cone. You should use the Long Elliptical shape, because it has the lowest drag. Don't use the high drag shapes like the Cupped Cylinders.

Putting holes in the Cupped Cylinders does not make a big difference at all because the drag does not go down.

Further work that would clarify or extend the results obtained:

I would use more nose cone shapes and maybe tail cones. I think it would also be better to test the shapes at higher wind speeds.

Credits:

I would like to thank these people:

My dad helped me make the nose cones and make a nose cone chart, and find references.

My mom helped me type this report.

The people at the Air Force Academy helped me with the wind tunnel: Christopher A. Seaver, Katrina L. McGuire, Ken Ostasiewski.

Summary

My R&D was about the drag of nose cone shapes. The drag is a force of resistance, which is a push or a pull. I got this idea from my dad's book "69 Science Fair Projects With Model Rockets." The first nose cones I got were some of the Science Fair nose cones assortment from Apogee Components. These were all balsa wood and I sanded these first. I then glued them to seal them. Then I lightly sanded all the balsa wood nose cones again to make them a little smooth. Then I painted and wet sanded them. My dad helped me make two of the other nose cones. One of the nose cones was a plastic one from a kit. The last nose cone was a vacuum-formed nose cone with a tube added to make it 2 inches long. All the nose cones were the same length. I used a total of 9 nose cones.

I went to the Air Force Academy to use their wind tunnel to test the nose cones. I put each nose cone through a wind tunnel to find the drag of each nose cone. Each nose cone was put in a body tube that was held by a black tube holder. Then air was sucked through the tunnel and the computer measured the drag force. We got the results at the end of the testing.

The results showed that the Long Elliptical Shape was the best nose cone. The second best was the Parabolic Nose Cone. The order for the rest was: #3 Long Cone; #4 Short Elliptical; #5 Ogive; #6 Short Cone; #7 Solid Cylinder; #8 Vented Cupped Cylinder and #9 Cupped Cylinder. The Cupped Cylinder had the most drag.

This experiment was a surprise because my prediction didn't really match, and I thought it would match.