



Safety First!

The Downwind Prang

One cause of a Really Bad Day on the range

Ted Cochran, NAR 69921

The rocket, rising majestically, but at an ever-increasing angle, twangs off of the rod and makes



Ted Cochran

a low-altitude, downwind pass over neighboring pads before implanting itself into the ground under power.

It sits there, smoking, until the ejection charge goes off and the crumpled rocket body makes its final (backward) flight away from the buried nose cone. The downwind prang has claimed another victim.

Uh oh.

Last issue I discussed rod tilt and its effect on weathercocking, in which the rocket turns upwind. The downwind prang looks somewhat similar, but has a different root cause.

The primary cause of the downwind prang is low velocity on the rod. If the rocket rises too slowly, the wind starts to blow it sideways while it is still on the launch rod, and the launch rod starts to bend. As the

Going Ballistic, continued on page 2

ALSO IN THIS ISSUE

- 3** Event Schedule; President's Corner
- 4** 2003 MASA Officer Candidate Statements
- 6** Scale Data: Brazil's VLS
- 12** Milestones; Parting Shot

High Tech

Turn Your Own Nose Cones on a Lathe

Part 1: Design

by Jon Hayman and Katie Hayman

When we read Kerry Hodge's "Rocket Rhinoplasty" article in the last issue, we wholeheartedly agreed with his preference for unusual nose cones. Not many unique nose cones are available outside of BMS custom work or rolling your own. My daughter and I used to have the habit of adding kit nosecones to our scrap box in favor of using better-looking nose cones from BMS. I think Estes had a much wider and nicer-looking selection of nose cones in the 60's, when I first got started in rocketry, than they do today.

For about 2 years, we have been turning our own nose cones on a 40-year-old Sears lathe, and we'd like to share our methods. In this part, we will discuss designing and laying out your nose cones in preparation for turning on a lathe. In the next issue we will show the methods we've used to get the best results on a lathe.

For drawing nose cones, it is helpful to have a large sheet of stiff cardboard (e.g., the inside of a large cereal box) or graph paper. Larger sheets of graph paper are available from art-supply stores. You will also need a steel ruler (or French curve for smaller nose cones), a pair of dividers, and a pencil. There are three primary methods we use to design nose cones.

Free Hand drawing

So you don't like equations to plot nose cone shapes, but you want to draw a nose cone shape quickly? The basics of drawing tangent ogives and secant ogives were covered in the last newsletter.

Nose Cones, continued on page 2

Ballistic, continued from page 1

rocket rises, it leans farther and farther to the side, and ultimately exits the rod at an unintended angle.

The effect may be amplified as the rocket reaches the end of the rod, especially if the lug (or the lowest lug in a split design) is low on the airframe or the rocket is upwind of the rod. In this case, the rod holds the bottom part of the rocket while the wind continues to push the top of the rocket over even as the rod springs back. The rocket may thus pivot well beyond the already significant angle of the bending launch rod.

A nasty example of rod whip

This effect is a particularly nasty example of *rod whip*, which is the general term for crooked flights caused by flexible rods. [Rod whip can also be caused by large diameter rockets with small diameter motors, vectored thrust, heavy rockets on flexible rods (especially when tilted), and improperly positioned launch lugs.]

Some fliers try using a longer rod in this situation, but longer rods may make things worse! A stiffer rod (or a rail) *may* help, but don't rely on it save the situation. If the rocket leaves the rod at too slow a speed, it may still be adversely affected by the wind, because the top of a slowly moving rocket can be blown sideways while the bottom is still attached to the rail. The fins can't help until the rocket is free of the rod!

The key to avoiding this problem is to have the rocket spend as little time on the rod as possible, and leave the rod at a speed of at least 30 feet per second (the approximate speed at which the fins begin to work). This means making sure that the rocket has a high thrust-to-weight ratio, moves easily on the rod, and is not impeded at take-off by the igniter leads.

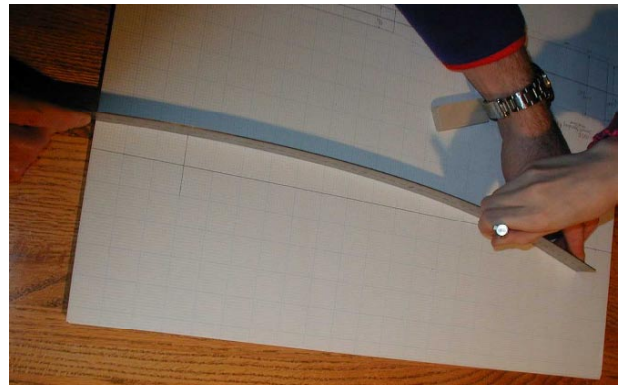
The accompanying picture shows Seth Cochran's Fat Boy in the early stages of a downwind prang. The normally reliable Fat Boy was a bit overloaded with a very long streamer made of plastic CAUTION tape. Worse, it was impeded on its initial journey up the rod by the shutter release mechanism for a pad-side camera, and still worse, it was upwind of the rod, causing the motor to push it over even more. Happily, the rocket was undamaged by this misadventure, and continues to fly to this day.

May yours do likewise!



Nose Cones, continued from page 1

For rockets of your own design, you can create a great-looking nose cone shape by just bending a

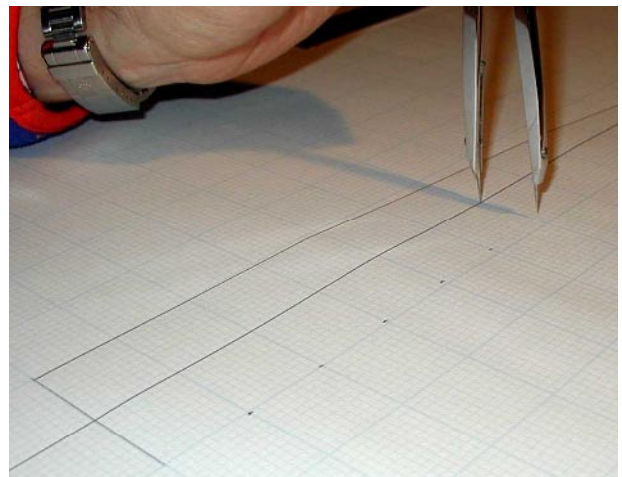


Jon Hayman

A quick way to draw a nose cone.

steel ruler and marking the resulting profile on a sheet of paper or cardboard as shown above.

First, draw a center line representing the radius of the nose cone down its entire length, and at one end,



Jon Hayman

Reflecting the design for symmetry.

draw a vertical line through it with marks to represent the nose cone's base diameter (matches the outside diameter of your body tube). Then, figure out how long you want to make the nose cone and put a mark on the centerline for the nose cone's tip. Bend the steel ruler between the shoulder mark on one side and the tip on the centerline. When you have the desired shape, draw a line along the profile of the ruler. You only need to draw the profile on one side. From the shoulder line, make a mark on the centerline every inch until you reach the tip. These marks are called "stations" and will be used to represent the diameter of the nose cone at a specific point.

Nose Cones, continued on page 8

MEETING SCHEDULE

TUESDAY, JANUARY 7

Location: [Science Museum of Minnesota, St. Paul](#)
Time: 7 PM to 8:45 PM
Topic: 2003 MASA Officer Elections

TUESDAY, FEBRUARY 4

Location: [Science Museum of Minnesota, St. Paul](#)
Time: 7 PM to 8:45 PM

TUESDAY, MARCH 11

(ONE WEEK LATER THAN USUAL)

Location: [Science Museum of Minnesota, St. Paul](#)
Time: 7 PM to 8:45 PM

FRIDAY, MARCH 21 TO SUNDAY, MARCH 23 NARCON 2003

San Diego, CA
See: <http://www.narcon2003.org/>

LAUNCH SCHEDULE

**NOTE: TIMES AND LOCATIONS SUBJECT TO CHANGE!
CHECK THE WEB SITE FOR UPDATES**

SATURDAY, JANUARY 25

Location: [White Bear Lake](#)
Time: 9 AM -Noon

SATURDAY, FEBRUARY 22

Location: [White Bear Lake](#)
Time: 9 AM -Noon
Team America Challenge flights

SATURDAY, MARCH 22

Location: [White Bear Lake](#)
Time: 9 AM -Noon



Snapshot



In a display of rocketry prowess, the Florida boys launch their 3xAC 2,170,000 + 2x AE 13,800,000 cluster RG for yet another perfect flight.

President's Corner

Changes

Alan Estenson

In January, the other MASA officers and myself will be stepping down and transferring our duties to our successors. I'd like you to give them all possible assistance during this transition and throughout the coming year. While my tenure as club president will be ending, I will be continuing as club webmaster and you'll certainly continue to see me at club events. During my recent move, I realized that I have a *lot* of model rockets. Hopefully, I'll have time to fly many of them next year and to take more photos.

Elections of 2003 MASA officers will be held at the January meeting. If you can't be present at that meeting, you will have an opportunity to submit an Absentee ballot via email; details will be sent out the week prior. If you don't have email, phone me(763 315 3462) and we'll work out a way for you to submit your vote. Remember that each MASA membership gets one vote. If you pay for an individual membership, you get one vote. If you pay for a family membership, the entire family gets one vote. (i.e., A family of four gets one vote, not four.)

I'd like to thank you for your support and hard work over the past two years. While a club needs good leadership, it also requires a superb roster of members. I'm very proud of our accomplishments- launches, meetings, outreach, tours, contests, parties, NARTREK, newsletters, web site... with more yet to come.

"The final test of a leader is that he leaves behind him in other men the conviction and the will to carry on."

Hot Jets!

Alan Estenson, MASA President (almost emeritus)

2003 Dues

This issue of the MASA *Planet* is sent by U.S. mail to all members registered as of December 2002, mostly to give you a chance to read this notice :-).

2003 Dues (\$10 Individual, \$12 Family, \$5 Junior) are now due. The next *Planet* will be sent by U.S. mail only to those who have renewed their memberships (and requested that it be mailed to them). To renew, visit:

<http://www.mn-rocketry.net/masa/joinmasa.htm>

Candidate Statements

Each of the MASA officer candidates was given the opportunity to use this space as they saw fit.

President

Glen Overby

MASA seems to be starting a tradition of running presidential candidates unopposed. So, pending a last-minute write-in campaign or "none of the above" getting more votes than I do, I'll be succeeding Alan as MASA President.

I think my biggest challenge will be sustaining the membership and participation level of the club. NAR has already seen membership start to dip which they attribute to the economy, and we're certain to feel that on the local level as well. I believe the best way to do this is to keep fun, interesting and informative. I plan to continue the monthly fun contests, NARTREK and "Pink Book" contests. I'm also looking for new things to try out.

I'd like to explore expanding the geographic diversity of our launch sites. We've been using three sites on the north side of the metro area, and I've wondered if it would help the club to have other sites in and around the metro area. I'd like to find "winter" fields of the size of the Sunrise Middle School (White Bear Lake) or larger in other places around the metro area.

If you have ideas for how to make MASA a better club, I would like to hear from you.

Vice-President

Mike Erpelding

Hi my name is Michael Erpelding. I'm 27 years old. I live at home with my parents on our family dairy farm in Luxemburg Township, Stearns County, about 4 1/2 miles north of Watkins, MN; which is located in Meeker County. I'm just a couple miles from the Powder Ridge Ski Area. I also enjoy woodworking, fixing stuff, country, old time, and classic rock n' roll music.

I am a journeyman electrician. I work for Cold Spring Electric Services Inc. Cold Spring Electric is one of the St. Cloud area's largest electrical contractors. We are a local #84 United Construction Workers/ Christian Labor Association union shop. We specialize in health

care, commercial, and industrial wiring. For the last two years I've mainly been in the service van. I do mostly residential, agricultural, and light commercial wiring. Pretty much I work wherever the telephone takes me in our area.

I was a 4-H member from 1987 to 1994. I launched my first rocket in 8th grade technology class in the spring of 1989. After that I made a rocket for the 4-H Aerospace project every year for the county fair. When I was a junior in high school, our extension agent put me in charge of the 4-H rocket launch at the county fair. I've been doing it ever since. I still try to teach one 4-H rocket workshop each year. I've also been a 4-H judge for the Stearns, Wright, Sherburne, and Hennepin county fairs.

I joined the NAR in August 2001. (This was also when I first learned how to use the internet. :0) I was hoping to learn more about the hobby; both to challenge me more and to find new things to keep older 4-Hers interested in the project. I was surprised how big the hobby was! It's way more than just Estes!

I mailed in my MASA membership application in mid January 2002 from the web site. I've been very happy since then. This is one of the friendliest and knowledgeable groups that I have ever been a part of. That was the best \$10 that I ever spent. I am very honored to be nominated for Vice President. Usually I had to be a member for a while of most organizations before I was asked to be an officer. I have plenty of room in my heavy-duty 3/4 ton long box pickup to haul launch equipment and supplies to the launches. If I'm elected, I would be happy to help whoever gets elected president (Glen ;>) and whoever gets elected Sec/ Treasurer with whatever needs to get done for the club. Thanks!

Secretary Treasurer

Lee Frisvold

Well it started in 1968 when a neighbor shot up a WAC Corporal in his back yard and I was hooked, I was 8. My first kit was the Estes V-2 that I still have and fly. I ended up with almost every rocket in the 1970 catalog and most my time was spent at Jollys in Southtown. I got out of rockets in 1973 due to music and girls in that order with my rocketry giving away to Stratocaters and Marshalls. Flash forward to Fall of 98 when Mollie and

I were cleaning my mom's basement and we came across a box of rockets that survived, she was very interested so I restored the V-2 and flew it. I became a BAR spending way too much money on another hobby and Mollie liked the building. As to the secretary job I will do what ever it takes to keep this Club going and making it a fun time launching rockets for the experienced as well as the first timer as we were all one once.

Stuart Lenz

My work career has been as a computer programmer/systems analyst working with many of the fastest and most powerful supercomputers in the world. I have also been an Advanced First Aid and CPR instructor, an Emergency Medical Technician, injury simulation artist and instructor, competition driver and driving instructor, karate student and instructor, security guard, Japanese beetle inspector, husband and parent.

My most enduring hobby has been as a metal sculptor, my most enduring legacy.

I am not a BAR, but built plastic models and wire controlled aircraft in my youth. I also had a part in manned moon missions, performing the computer analysis and graphic display of moon rock composition and comparison with Earth magmas in the 1970s.

I am here now to encourage and pass the baton to the next generation of scientists and engineers.

David Whitaker

Hi, I'm running for secretary/treasurer of MASA this year so I thought I'd share some of my rocketry background with you. I built my first rocket when I was nine or ten. The only thing I remember about it was that it had big chunks missing from the fins. Since it was my first rocket, my model building skills were severely lacking. I don't think I ever successfully launched it. I tried a couple of times but my lack of knowledge/money and the crummy igniters/batteries I had combined to give me a bad experience. After a few years had passed, I did start building rockets again with a lot more success. Being older and having more spending money really helped alot! My favorite rocket of my high school years was an Estes Alpha. I had about 20 flights on it before I lost it in the weeds. My

second favorite rocket was an Estes Interceptor which is still sitting in my parent's basement.

After high school, I attended Virginia Tech and majored in aerospace engineering. After completing graduate school I got a job as a research contractor at NASA Langley Research Center. After that job ended, I found work at Cray Research supporting and optimizing CFD applications (computer codes) for Cray vector computers. My job change required a move from Virginia to Minnesota, which was only a little 'shock'!

I then spent several years being busy with work and very small children.

Eventually, I saw the movie 'October Sky' which re-ignited my interest in model rocketry. I bought a Quest Micro-Max set at Toys 'R Us and I launched those in the backyard. Even though the igniters were extremely poor and difficult to work with, I was hooked again. I got a Estes RTF set at Walmart and found that the current generation of Estes igniters were actually pretty good! I was soon buying more Estes kits and putting them together. I launched in the city park next to my house and I soon developed a taste for bigger rockets. Particularly, the LOC and Aerotech kits I saw in the hobby store. I also discovered MASA on the worldwide web. I noticed that they could launch 3.3 lb rockets and H motors at their field in Blaine. I joined up and started attending the meeting and launches and had quite a good time. It was also my first experience with 'large model rockets' and motors bigger than 'D'. The exposure to other rocketeers and different types of rocket kits and motors was really an eye-opening experience.

Snapshot



November 20
inaugural
launch of the
Delta IV goes
perfectly!

Scale Data

Brazil's VLS

Veiculo Lancador de Satelites

Compiled by Ted Cochran, NAR 69921 SR

Brazil has had a successful rocket program since the 1960s, and has launched over 200 of their Sonda sounding rockets. Brazil has also has a successful satellite program that has used NASA's Pegasus and Chinese CZ-4B launch vehicles. The VLS is Brazil's first indigenous satellite launcher.

The Vehicle

The VLS is designed to lift 380 kg to low earth orbit. Development began in the late 1980s, but has been severely constrained by U.S. and Europe's export restrictions on guidance systems and motor technology. The rocket consists of seven solid propellant stages—three in the core vehicle and four strap-ons—with additional solid motors used for roll control. The first launch attempt was at Brazil's Alcantara site on 2 November 1997, but one of the

SRBs failed to ignite (they should have used Thumper :-). Although the rocket maintained attitude and an upright trajectory, it eventually deviated from its planned course and the rocket and its SCD satellite payload had to be destroyed. The second launch, on 11 December 1999, was more successful, but the second stage failed to ignite and the rocket and payload, a Brazilian SACI satellite, again had to be destroyed. A third launch attempt may occur in 2003.

Modeling considerations

The configuration is fairly unique, and it may well be the only scale model with turquoise paint that you'll ever encounter. The available data are pretty sparse, but I've managed to put together a reasonable package based on the sources below (If it was in Peter Always' seminal book, I wouldn't be writing about it!) If you're interested in the general configuration but want a model that is easier to stabilize, a 1/3 scale model of the VLS, but with fins, has been flown at least twice as a sounding rocket, beginning in May, 1989. The *Jane's* reference has more details on that prototype. 🗼

References

Janes Space Directory, 1997, pp. 205-207

<http://www.astronautix.com/lvs/vls.htm>

<http://hea-www.harvard.edu/QEDT/jcm/space/images/lv/97F03.html>

<http://hea-www.harvard.edu/QEDT/jcm/space/images/lv/99F05.html>

Specifications

Length:	19.5m
Diameter:	1.0 m, with 4 x 1.0m strap-on SRBs.
Weight:	49,600 kg



1/3-scale test vehicle.



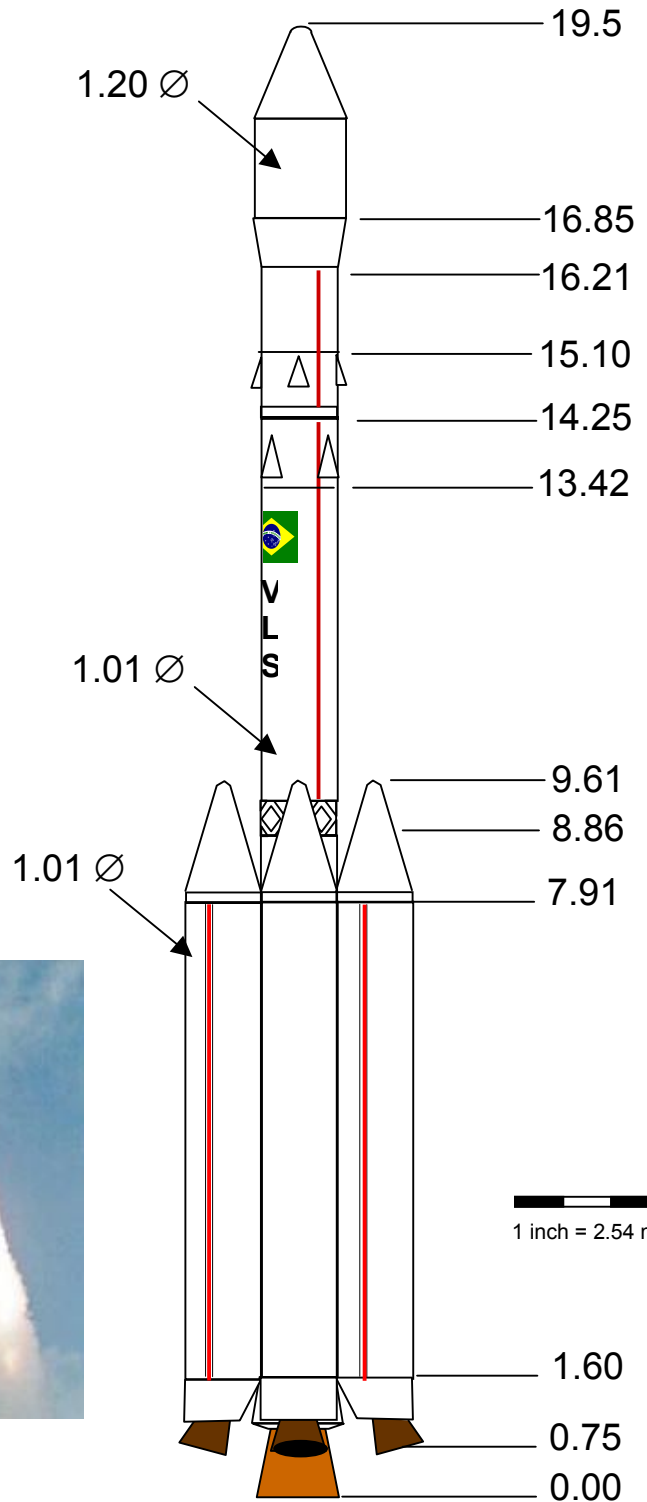
Vehicle 1.



Vehicle 1.



Vehicle 2.



Best available photo of VLS, vehicle 1. The red lines are external conduits. The protuberances in the first ring below the payload section are antennae; the second ring consists of solid rockets for the roll control system. Note latticework at the top of stage 1 and a ring of what appear to be decals above that.

Right: Vehicle rises on the plume of four solid rocket motors, each the equivalent of an X309000. You can approximate a full scale version of this SRM: simply build a 20 stage rocket, with each stage having 51,000 C6-0 motors in it. :-)

Veiculo Lancador de Satelites (VLS)

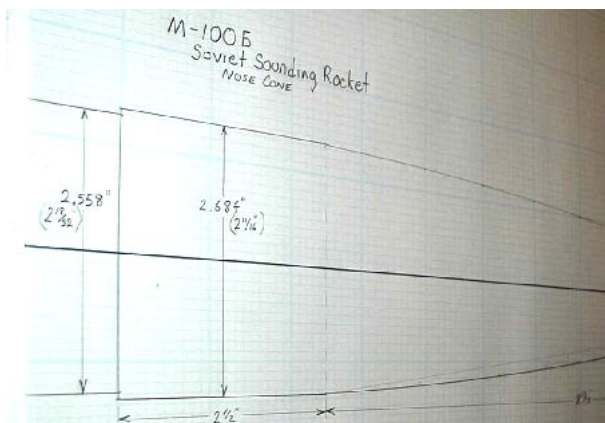
1:100 scale

Nose Cones, continued from page 2

Then, using a pair of dividers, match the vertical distance at each station to the profile you drew, and make a mark on the other side of the centerline. You now have the diameter of that station. You can use the ruler to connect the marks to get the matching profile on the other side, but this isn't necessary. To turn the nose cone on the lathe, all you need is the diameter at each station. The last thing you need to draw on the other side of the base diameter line is the shoulder or tenon (the part that sticks inside of the body tube). The outside diameter of the tenon is simply the inside diameter of the body tube. You can get this measurement from the catalog of the vendor or measure it yourself with a ruler or dial calipers. The length of the tenon is up to you.

Scaling a prototype or drawing

In this method, you are trying to duplicate a nose cone from a real rocket, using a drawing from, for example, Peter Always' book, *Rockets of the World*. Always' book gives most or all of the dimensions needed to scale rocket parts down to the desired size. Scaling is easy to do and is discussed in Chapter 16 of Harry Stine's book, *Handbook of Model Rocketry*. Basically, you first determine a scaling factor, which is the relation (or ratio) between the size of a part on your model divided by the size of the same part on the real rocket. The airframe diameter is the most common dimension used for this purpose: Divide the diameter of the airframe of the model by the diameter of the real airframe you are using to get the scaling factor. You then multiply every dimension of the real rocket by the scaling factor to give the model dimension. The example below shows a drawing of an M-100b Soviet nose cone, scaled to fit a 2.68" body tube.



Drawing the Soviet M-100b Nose Cone.

Always' book doesn't give detailed dimensions of curved parts. Those can be estimated by using a different scaling factor based on the actual drawing as it appears in the book. To increase the accuracy of your results, use the largest available drawing of the nose cone for scaling. To get the scaling factor, you divide your model body tube diameter by the diameter of the rocket on the page (use a pair of dividers or ruler and measure to the nearest 1/32 or 1/64 inch, if

In Pursuit of Mach 1

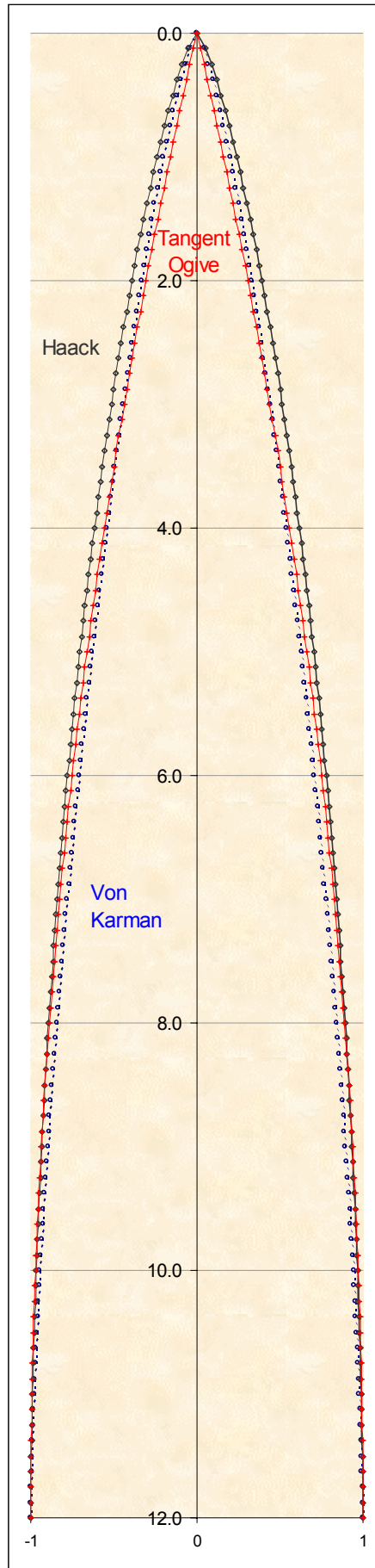
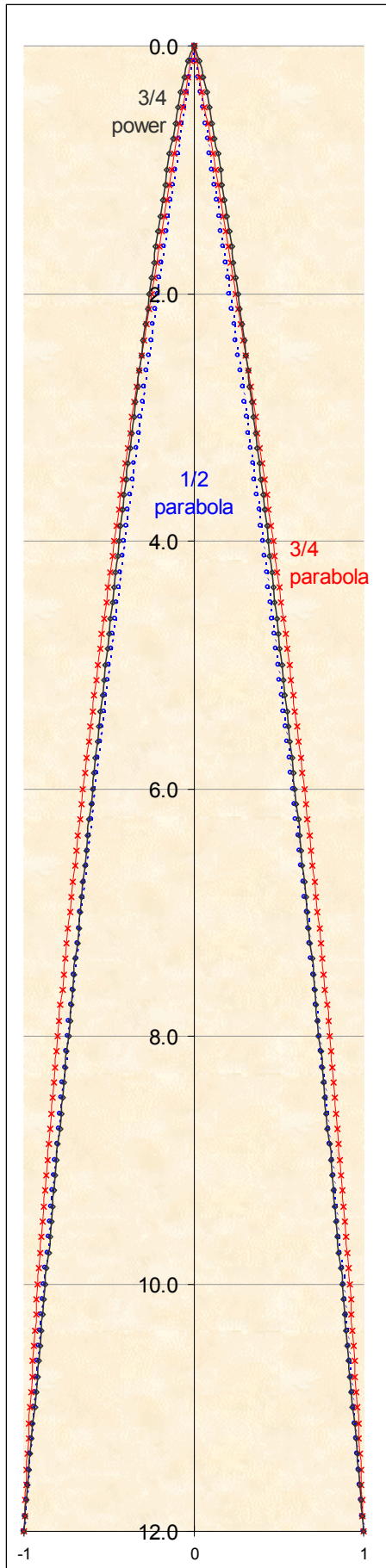
possible). Then, multiply this value by whatever other dimensions you measure from the diagram on the page to get the dimension you need for the model. For curved nose cone sections, split the length of the curved section of the drawing into 3 or 4 equal parts, and do the same to the model nose cone drawing you have in progress. Then, transfer the scaled radius at each of the 3 or 4 points in the book drawing to your model drawing, and use a French curve or bent steel ruler to connect the points.

In summary, to scale down from the real thing, compute a scaling factor by dividing the model size by the real size, and multiply every real rocket dimension by the scaling factor. To scale up from a small drawing in a book, compute a scaling factor by dividing the model size by the smaller drawing size and multiply every drawing dimension by that scaling factor.

Technical Nose Cones

You may have seen references in books or magazine articles to Von Karman or Sears-Haack nose cone shapes. These and other shapes such as parabolas and power series have been studied for supersonic flight. According to *Missile Configuration Design* by S.S. Chin, the most efficient nose cone shape for supersonic flight appears to be Von Karman, with $\frac{3}{4}$ / $\frac{1}{2}$ parabola, and $\frac{3}{4}$ power series close behind. The Von Karman shape is essentially a flattened tangent ogive, but it becomes a little wider than the tangent ogive towards the end of the tip. The Haack shape is a little wider than the other two, and is only efficient at lower mach numbers. Based on Chin's book, and on "In Pursuit of Mach 1," an article in the Oct. 1983 issue of *Model Rocketeer*, we have summarized the methods to generate these special shapes. To use the

Nose Cones, continued on page 9



formulas that follow, it is helpful (or necessary!) to have a programmable calculator, or software such as MathCAD or Excel to generate the radius measurement at a given station based on your nose cone base diameter and total length. You can also write a C program to do this. For convenience, the Haack equation is shown as you would enter it on a TI programmable calculator. If you use Excel, remember that calculations with trig functions use radians, not degrees (there are 2 pi radians in 360 degrees). We have included a table of sample data for these nose cone shapes if you want to test your equations before use.

To turn these shapes on a lathe, you do not need to plot them first on paper unless you want to see what they look like. All you need for turning is a list of data – the station, and the diameter at that station.

The graphs to the left were generated in Microsoft Excel using the equations in on the next page. Since we had to fit a twelve-inch nose cone graph on an eleven-inch page, they aren't exactly to scale. But you can see the differences in the shape, and with a little work, you can generate your own graphs to fit any design that you can think of!

In the next issue, we will discuss tools and techniques for turning these designs into reality!

References

Chin, S.S., *Missile Configuration Design*, McGraw-Hill, 1961
 Stine, Harry G., *Handbook of Model Rocketry* (Sixth Edition), John Wiley & Sons, Inc., 1994
 Alway, Peter, *Rockets of the World*, Saturn Press, 1999
 Donatelli, Geoffrey. "In Pursuit of Mach 1; Design for Supersonic Flight" *Model Rocketeer*, October 1983

Tables and data continue on page 10

Nose Cones, continued from page 9

Stations or distances from nose tip	Tangent Ogive, base dia = 2", L=12	Note: "x" values here do not apply to Tan ogive	Sample Nose Cone plot data for base diameter = 2" and total length = 12"				Sample Nose Cone plot data for base diameter = 3" and total length = 12"					
			Von Karman, where C = 0		L-V Haack, where C = .333333		¾ Parabola series		½ Parabola series		¾ Power series	
x_{sta} (")	$y(x_{sta})$ (")	x	r	r_{act} (")	r	r_{act} (")	r	r_{act} (")	r	r_{act} (")	r	r_{act} (")
0.5"	.0821	.0416	.1193	.1193	.1448	.1448	.0655	.0983	.0549	.0824	.0921	.1382
1.0"	.1607	.0833	.1994	.1994	.2402	.2402	.1291	.1937	.1088	.1632	.1551	.2327
1.5"	.2356	.1250	.2686	.2686	.3207	.3207	.1906	.2859	.1615	.2423	.2102	.3153
2.0"	.3070	.1666	.3309	.3309	.3917	.3917	.2499	.3749	.2129	.3194	.2608	.3912
2.5"	.3749	.2083	.3885	.3885	.4558	.4558	.3072	.4608	.2633	.3950	.3083	.4625
3.0"	.4392	.2500	.4422	.4422	.5142	.5142	.3625	.5438	.3125	.4688	.3536	.5304
3.5"	.5000	.2916	.4925	.4925	.5677	.5677	.4155	.6233	.3605	.5408	.3968	.5952
4.0"	.5573	.3333	.5401	.5401	.6170	.6170	.4666	.6999	.4074	.6111	.4387	.6581
4.5"	.6110	.3750	.5853	.5853	.6624	.6624	.5156	.7734	.4531	.6797	.4792	.7188
5.0"	.6613	.4166	.6279	.6279	.7043	.7043	.5624	.8436	.4976	.7464	.5185	.7778
5.5"	.7080	.4583	.6686	.6686	.7429	.7429	.6072	.9108	.5411	.8117	.5570	.8355
6.0"	.7513	.5000	.7071	.7071	.7785	.7785	.6500	.9750	.5833	.8750	.5946	.8919
6.5"	.7911	.5416	.7436	.7436	.8111	.8111	.6906	1.0359	.6244	.9366	.6313	.9470
7.0"	.8274	.5833	.7782	.7782	.8410	.8410	.7291	1.0937	.6643	.9965	.6675	1.0013
7.5"	.8602	.6250	.8109	.8109	.8682	.8682	.7656	1.1484	.7031	1.0547	.7029	1.0544
8.0"	.8896	.6666	.8415	.8415	.8928	.8928	.7999	1.1999	.7407	1.1111	.7377	1.1066
8.5"	.9155	.7083	.8702	.8702	.9149	.9149	.8323	1.2485	.7772	1.1658	.7721	1.1582
9.0"	.9379	.7500	.8969	.8969	.9346	.9346	.8625	1.2938	.8125	1.2188	.8059	1.2089
9.5"	.9569	.7916	.9214	.9214	.9518	.9518	.8906	1.3359	.8466	1.2699	.8392	1.2588
10.0"	.9724	.8333	.9436	.9436	.9666	.9666	.9166	1.3749	.8796	1.3194	.8722	1.3083
10.5"	.9845	.8750	.9633	.9633	.9791	.9791	.9406	1.4109	.9115	1.3673	.9047	1.3571
11.0"	.9931	.9166	.9799	.9799	.9890	.9890	.9624	1.4436	.9421	1.4132	.9368	1.4052
11.5"	.9983	.9583	.9928	.9928	.9962	.9962	.9823	1.4735	.9716	1.4574	.9686	1.4529
12.0"	1.000	1.000	1.000	1.000	1.000	1.000	1.500	1.5000	1.500	1.5000	1.500	1.5000

Notes:

1. Haack (and Von Karman) equation: $r = \sqrt{\frac{h - \frac{1}{2} \sin 2h + C \sin^3 h}{\pi}}$, where:

$h = \cos^{-1}(1 - 2x)$ r and x represent ratio values (see below)

$C = 0.333333$ for L-V Haack nose cones $C \sin^3 h$ can also be expressed as $C(\sin h)^3$

$C = 0$ for Von Karman nose cones \cos^{-1} is the same as ACOS (arccosine)

Above Haack equation above, when translated for a TI-68 Programmable calculator, looks like this:

$$r = \sqrt{([\cos^{-1}(1 - 2x)] - \sin(2 * [\cos^{-1}(1 - 2x)])) / 2 + C * (\sin[\cos^{-1}(1 - 2x)])^3) / \pi}$$

This equation was verified against Chin's sample nose shape data on p. 251 (see reference below). Be careful of your placement of brackets/parenthesis! Enter them exactly as shown, and test your equation using sample data above.

Nose Cones, continued from page 10

2. **Equation for Parabolic series:** $r = \frac{2x - Kx^2}{2 - K}$

Where: K=0 for cone shape
 K=1 for parabolic nose
 K=.75 for 3/4 parabolic nose (sample data in above table)
 K=.50 for 1/2 parabolic nose (sample data in above table)

3. **Equation for Power series:** $r = x^n$

Where: $n = 1/2$ (1/2 power series nose)
 $n = 3/4$ (3/4 power series nose) (sample data in above table)

For all of the equations above:

$$x = \frac{\text{distance from nose tip } (x_{sta})}{\text{total nose length}} \quad \text{and} \quad r = \frac{\text{radius at any nose station}(r_{act})}{\text{maximum radius(base of nose)}}$$

Thus, x and r in the above equations represent ratios:

- To get x for input into the above equations, you divide your current nose station (distance from nose tip, or x_{sta}) by the total length of the nose
- To get the actual radius (r_{act}) to plot at the nose station, multiply r (the result of each equation) by the maximum radius at the nose base. In the case of the above sample plots for the Haack/Von Karman nose cones, r_{act} is just equal to r since the radius = 1. For the Parabolic and Power series nose cones, all r values had to be multiplied by radius of 1.5 to get r_{act} .
- Note also that x_{sta} and x are the same for all nose cone types in the above table since we are using the same nose cone station increments (of 1/2 ") and the nose cone length is constant at 12".
- For plotting the above data, the (X, Y) coordinates are (X_{sta}, r_{act})

For the use of the above equations, there are three steps required to give you the radius at each station as described in Chin's book:

- determine "x" first from x_{sta} divided by the total nose length
- run "x" through the equations above to get "r"
- determine actual radius (r_{act}) by multiplying "r" by the maximum radius at the base of the nose

You can also calculate the radius directly by substituting in x_{sta} /total nose length wherever you see "x" in the

$$\sqrt{\left[\left[\left(\cos \left(1 - 2 \cdot \frac{x}{12} \right) \right) - \frac{\sin \left[2 \cdot \left(\cos \left(1 - 2 \cdot \frac{x}{12} \right) \right) \right]}{2} \right]^2 + \left[\sin \left(\left(\cos \left(1 - 2 \cdot \frac{x}{12} \right) \right) \right) \right]^3 \right]} \div \pi \cdot r$$

equations, and then multiplying the maximum radius at nose base by the result of each equation. For example, the MathCAD representation of the Haack/Von Karman equation is:

5. **Tangent Ogive equation** is: $y(x_{sta}) = \sqrt{R^2 - (L - x_{sta})^2} - (R - r)$ where $R = (L^2 + r^2)/(2r)$ and:

L = length of nose cone (ogive); r = radius of the base of the nose cone (note: not the same "r" as used above); R = the radius of the generating circle for the ogive; x_{sta} = the station relative to the nose cone tip, and y is the distance from the ogive centerline to the ogive surface/profile (in effect, the radius of the nose cone at a specific x_{sta}). In the sample plot data above, R is fixed at 72.5 (radius of generating circle) since L=12 and r = 1. The (X, Y) coordinates to plot from above equation are ($x_{sta}, y(x_{sta})$)

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Milestones

Welcome New MASA Members!

Tom and Nate Schleif

New High Power Certification

David Whitaker

Level 1 (October 26, 2002)
(Aerotech Sumo, H220)

New NARTREK Awards

David Gensler

Bronze (October, pending)

Ken Hoyme

Bronze (October, pending)

Ted Cochran

Gold (November 2, 2002)

David and Ken are the seventh and eighth MASA members to complete the requirements for NARTREK Bronze. Please let us know as you finish your flights!

Parting Shot: How to get an Alpha out of a tree!



It helps to have a member of the Fire Department in your club!



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