External Structures

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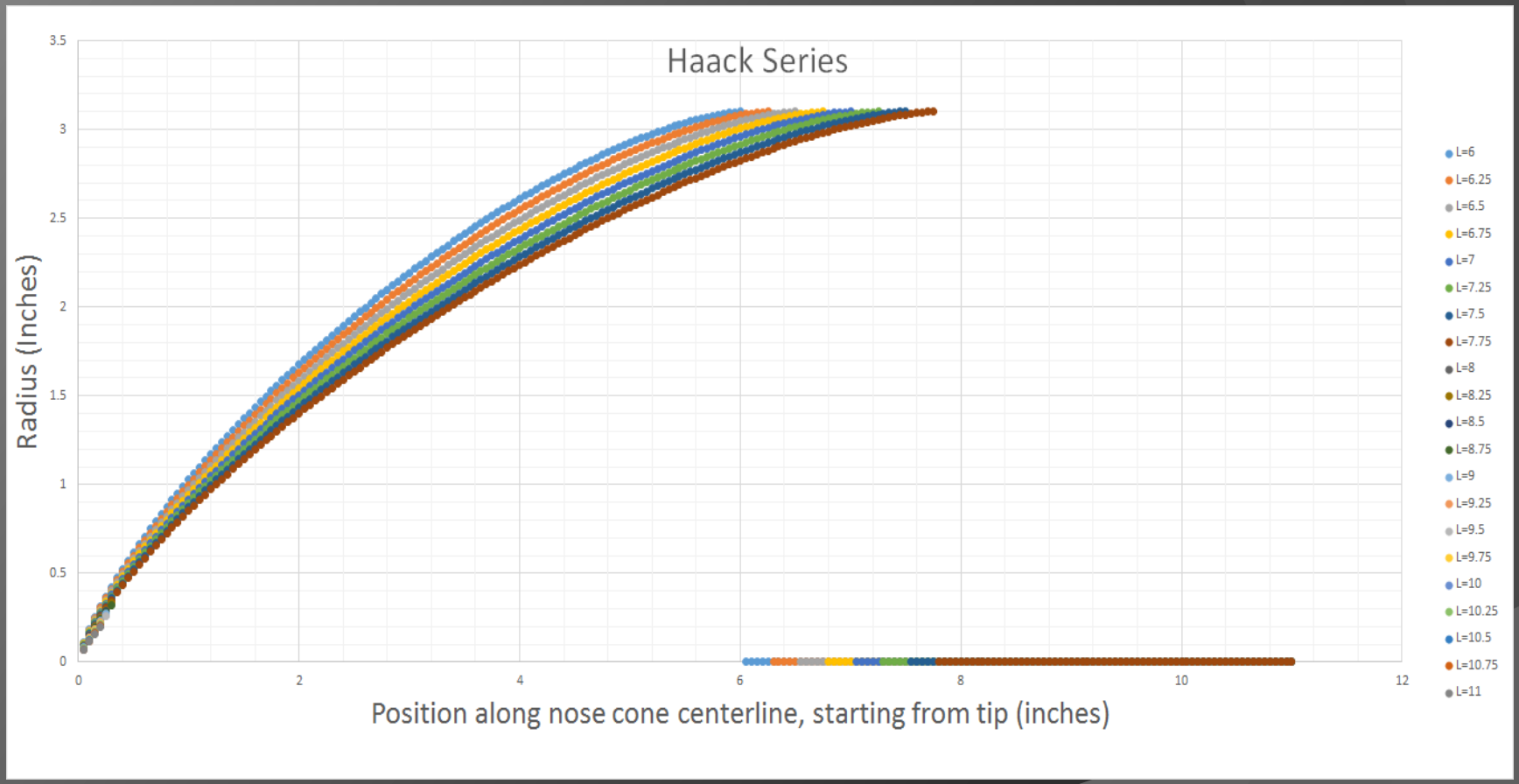
Overview

- **Nose Cone**
- **Body**
- **Fins**
- **Payload**

Nose Cone

- Designed small enough to be printed using the SLS printer
- Hollow nose cone allows for extra storage space
- Shorter length → less surface area → less drag
- Many different nose cone geometries, but for subsonic speed we chose to use the Haack series

Haack - Series



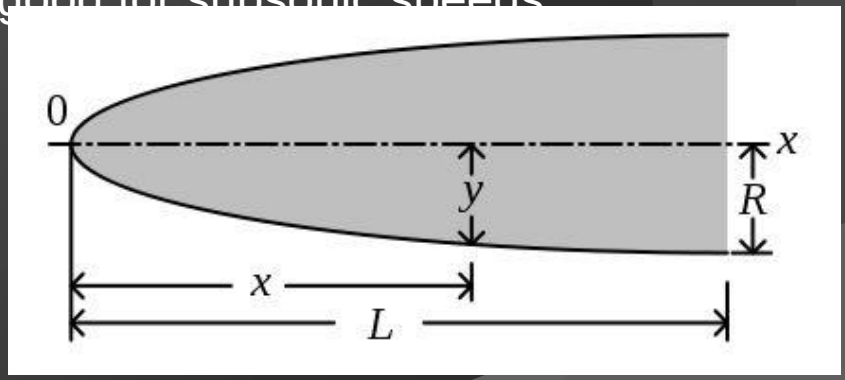
Haack - Series

- Creates a specific geometry based on the diameter (at the base) and length of the nose cone. The equation is derived based on the purpose of minimal drag.
- The tip is slightly rounded which is good for subsonic speeds

$$\theta = \arccos\left(1 - \frac{2x}{L}\right)$$

$$y = \frac{R}{\sqrt{\pi}}\sqrt{\theta - \frac{\sin(2\theta)}{2} + C\sin^3\theta}$$

C = 0 for LD-Haack



http://en.wikipedia.org/wiki/Nose_cone_design

Fuselage

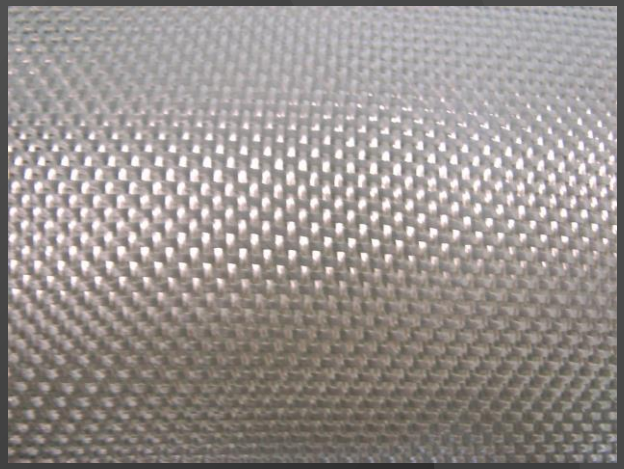
- Phenolic Tubing
  - Resin filled and heat treated
  - 5x strength of cardboard
  - 0.074in thickness x 6.007in ID
  - $41.99 per 4 foot section
  - Public Missiles Ltd.

- Coupler tube
  - 0.074in thickness x 5.86in ID
  - $44.99 per 4ft

- Shipping
  - 48 hour lead plus shipping time from MI

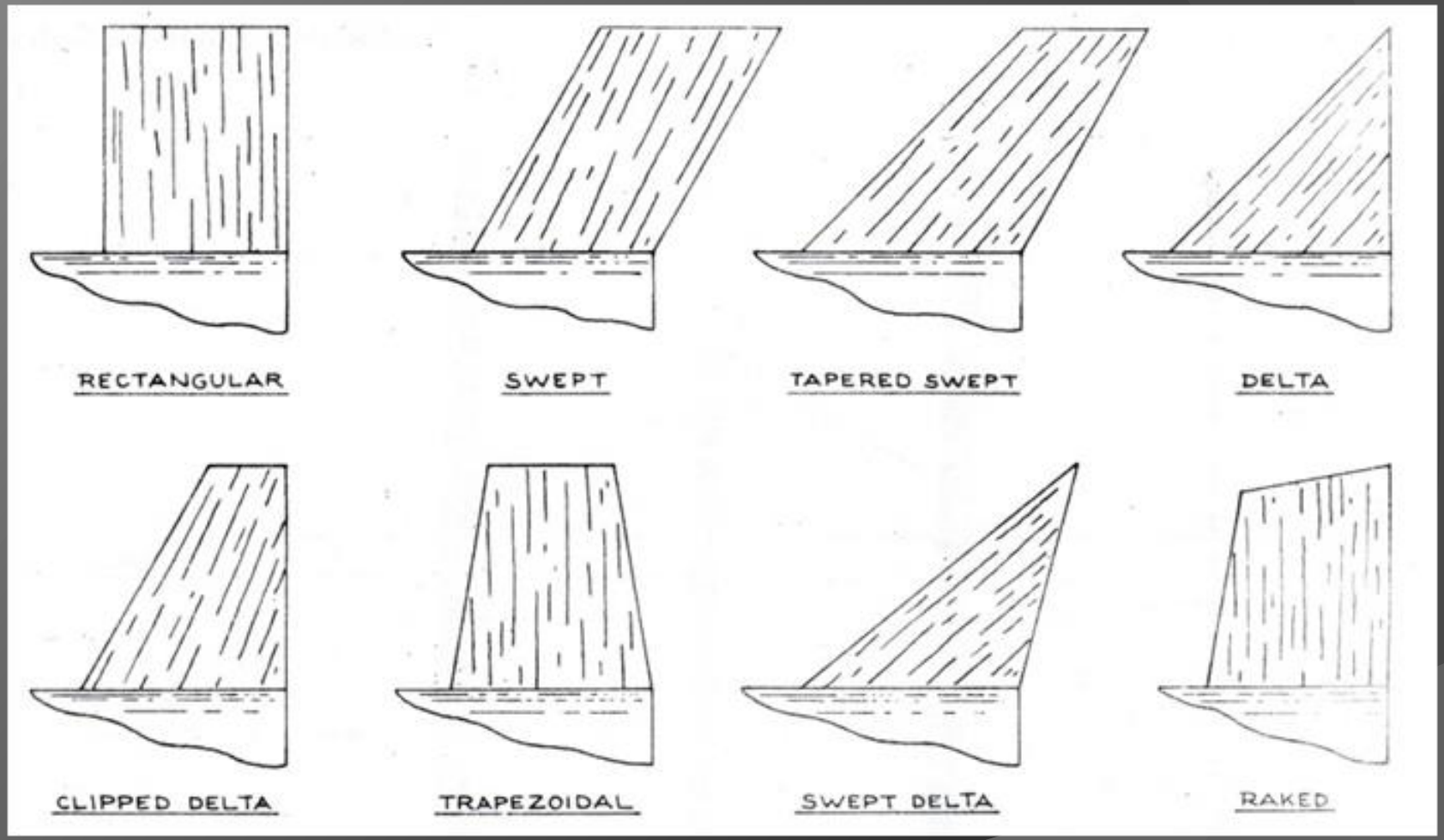
Fuselage

- Fiberglass
  - Resistant to 1100°F
  - 10ft x 60in x 0.035in: $96.60
  - McMaster-Carr



- Attaching
  - Lay phenolic tubes in series
  - Cut and place coupler inside of tube
  - Cut fiberglass to correct perimeter and length
  - Wet fiberglass and set around tubes

Fin Design

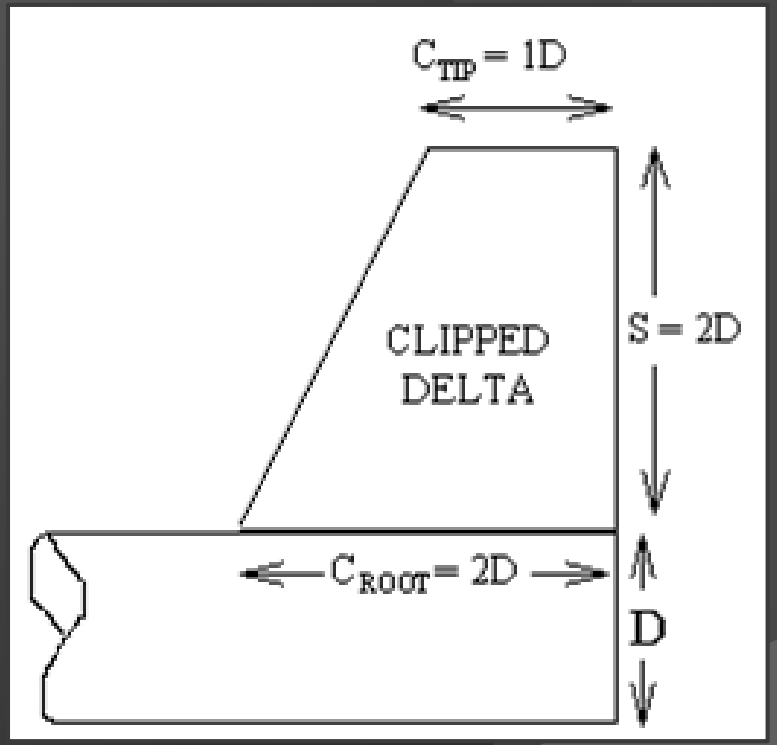


http://aerospace.eng.usm.my/spr/index.php/rocket-body-design/fin1

Clipped Delta Design

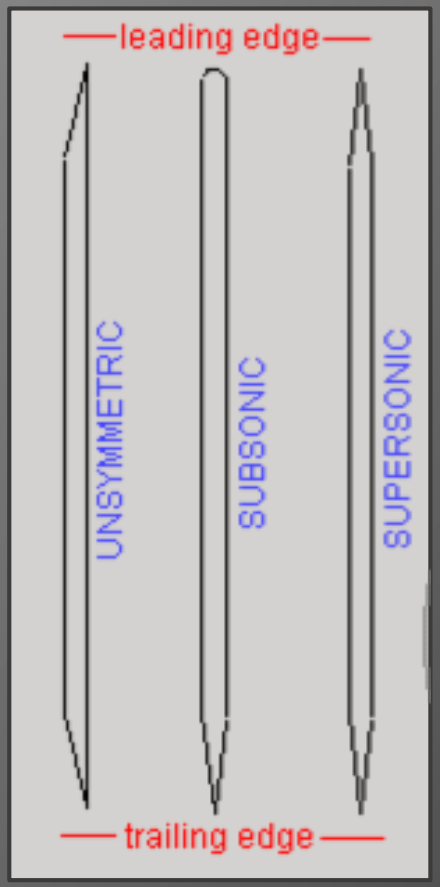
Dimensions
- Span=2x Diameter
- Root Length=2x Diameter
- Tip Length=Diameter
- Root width=0.1x Root Length
- Tip width=0.1x Tip length

3 or 4 fins for optimal drag
- 3 is less drag
- 4 is smaller fins

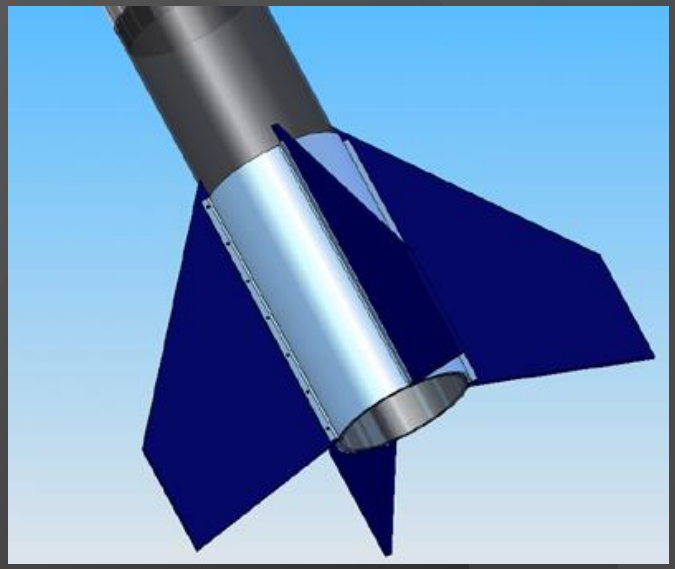


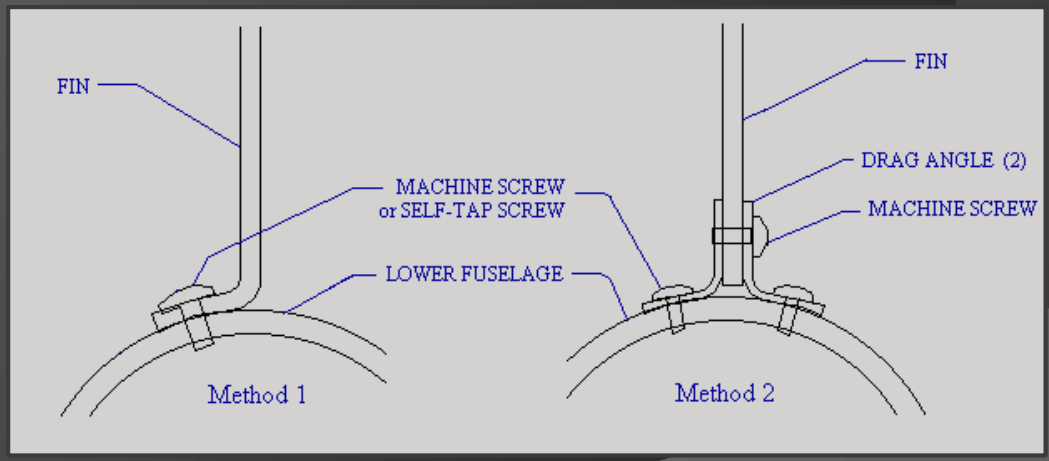
Source: G. Harry Stine. *Handbook of Model Rocketry, The* (6th Edition). © 1994, Published by John Wiley and Sons, Inc

Clipped Delta



Attaching Fins
-Fairing
-Bolt
-Slide in
-Compression Fit





http://www.nakka-rocketry.net/fins.html

Software

AeroLab
- written by Hans Olaf Toft
- estimates Drag, Lift and Center of Pressure for rockets flying at velocities up to Mach 8
- It also estimates the rocket's Center of Gravity and Moments of Inertia and performs stability analysis within the entire velocity range.

NACA 4 digit airfoil generator
Specification
- Maximum chamber
- Position of maximum chamber
- Thickness

Payload

SDL Payload Challenge:

Objective: Encourage participants in the IREC to create payloads that provide a useful learning opportunities and accomplish a relevant function.

Rules: To be considered for judging, the payload must:

- Weigh at least 10 lbs;
- Be removable from the rocket;
- Not affect the flight of the rocket if removed and replaced with ballast of the same mass and form factor;
- Be totally recoverable (i.e. no pieces of payload littering the desert);
- Keep within a 3 nautical mile radius of the launch site during flight;
- Not contain any live animals;
- Not contain any hazardous materials;

*****Bonus for K-12 Involvement:**

-Did the payload team involve students Kindergarten through 12th grade in some way, while still maintaining the necessary objectives and quality?

Payload

- **Possible Ideas:**
  - 10-lb weight (not enter in Payload Challenge)
  - **With K-12 students:**
    - Mechanical Accelerometer https://www.apogeerockets.com/education/downloads/Newsletter246_large.pdf
    - Camera
    - Vibration Detector http://www.instructables.com/id/How-to-make-simple-%22motion%22-sensors/
    - Egg Drop
    - Mechanical Apogee Detector https://www.youtube.com/watch?v=ldaHifNAxsg