Box Building

Introduction

Payload box building is more on the art side rather than engineering. They do need to be sturdy, recoverable, and take a 40 mph ground impact. Many designs will work. This document will share one version. A good place to start is with constraints for boxing and landing the payloads.

The University of Maine High Altitude Ballooning Team generally tries to reduce payload weight whenever possible and practical. As a result our boxes tend to be light. Because Maine has many water bodies, boxes need to float. As much as making the boxes waterproof would be nice, no box as of yet has kept all water out. Box design can help keep some water out but probably not all. Avoiding salt water landings is very important as it is very destructive to powered electronics.

Materials


The material for boxes that the team has settled on is rigid ¾" to 1" - 4'x8' foam insulation board from local home building supply centers. To connect foam pieces together, we use Gorilla Glue. It does take overnight for the Gorilla Glue to set and a day for a full cure. Shoulder washers are used to reinforce where the string exits the box. EconoKote is used to make the exterior of the box more durable and easier to locate. A long metal rod is used to hook and fish the string through the box string slots. Straws are used to reinforce the string slot.

Carefully file a cutting edge, like a drill bit, on one end of the long metal rod. It will be used like a drill bit to make several pilot holes. Then, carefully file a the other end roughly like a crochet needle. This will be used to snag a pull string through the string slot when stringing payload onto the payload system.

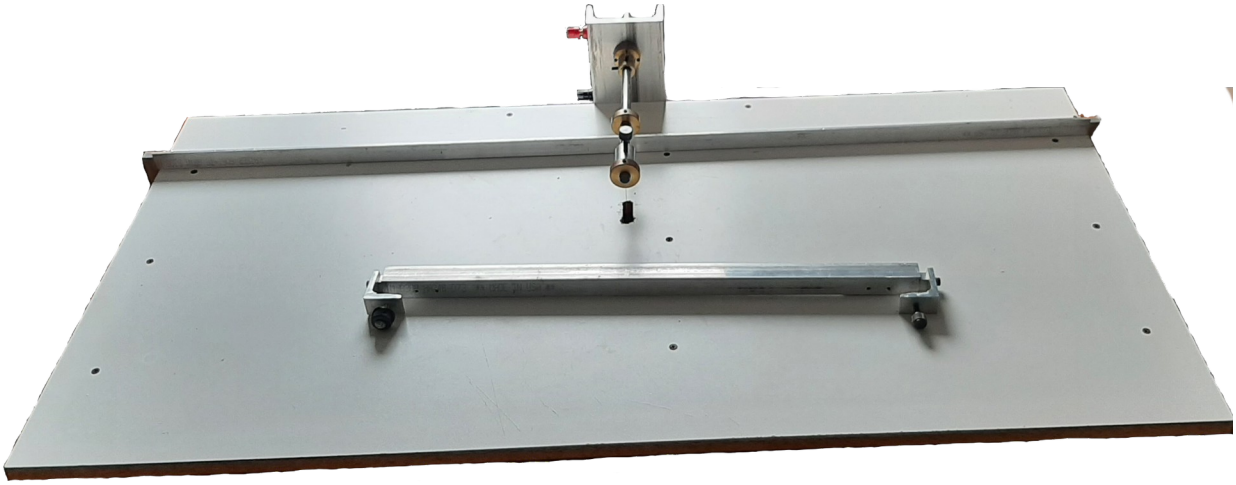
Cutting Foam

Use a hot wire cutter, shear, or sharp blade to slice up the rigid foam board. More detail will be given about the hot wire cutter in the next section.

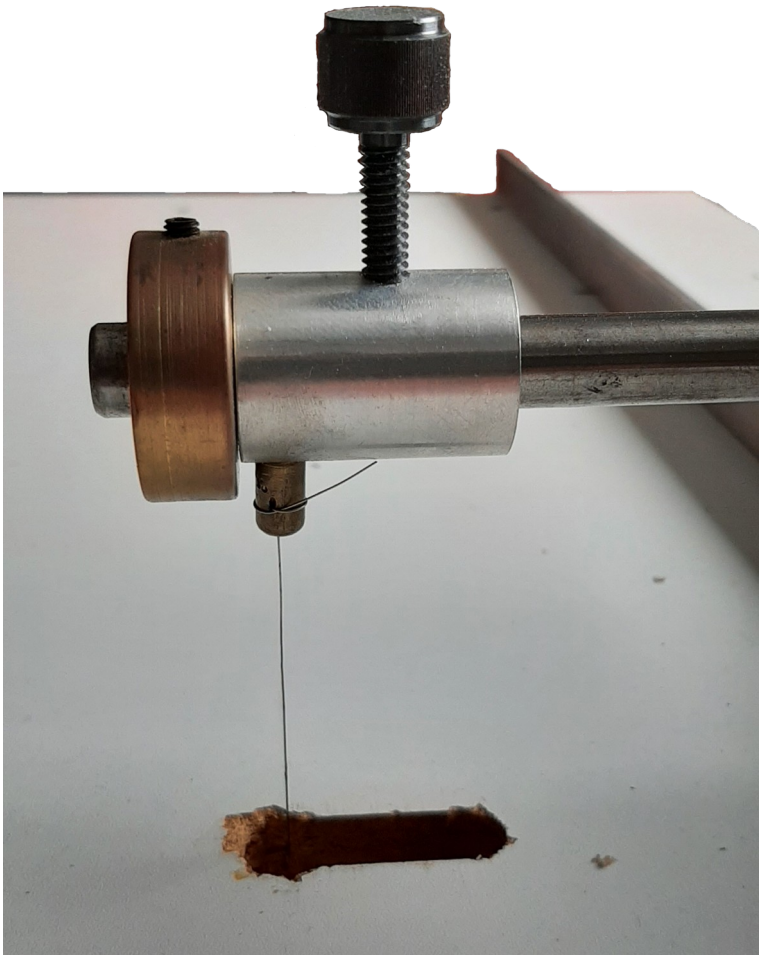
Hot Wire Cutter

To easily cut and shape the rigid foam board, the University of Maine High Altitude Ballooning Team built a homemade hot wire cutter. It roughly resembles a scroll saw but rather than a reciprocating blade, a current is sent through a taught thin nichrome wire. It was constructed from leftover parts from other past projects.

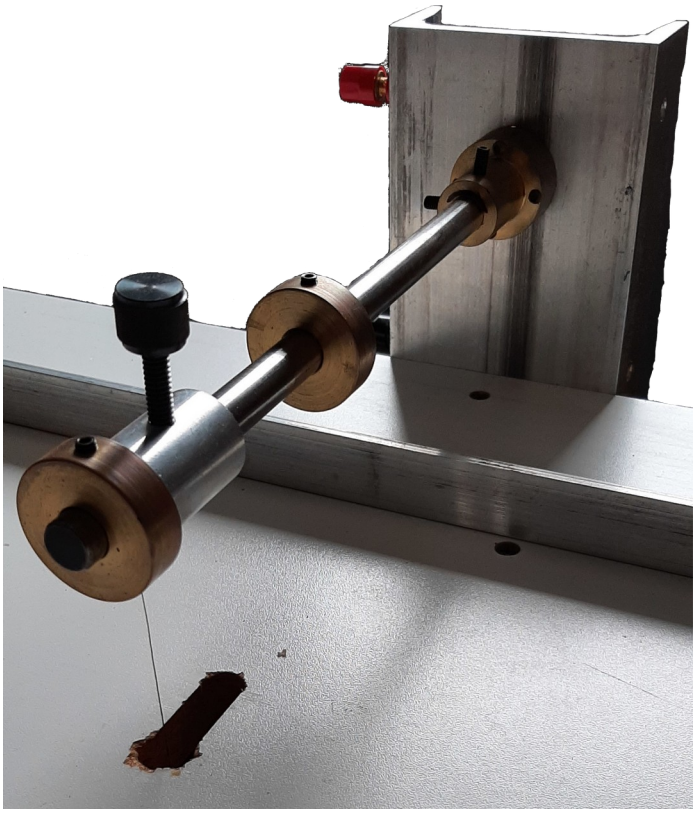
The following images show the hot wire cutter. Two fences are shown to make straight cuts, one short and one long. In the back of the cutter, attached to the aluminum C channel, are two binding posts used to connect a power supply. A reasonable current is about 1.7 amps for the nichrome wire length and diameter. The best method to determine the right current value is by experimenting.



This particular hot wire cutter has the ability to change the nichrome wire angle. The part that connects to the nichrome wire is slidable. The next figure shows the detail of the nichrome wire connection.



The metal shaft used to support the wire was pulled out of an old impact printer. The brass pieces are used as stops.



To keep the nichrome wire taught, a spring is used below the table. A pulley was machined and placed on a smooth bearing to change the direction of the nichrome wire and allow for movement when heated. The nichrome wire expands when it heats. The nichrome wire winds once around a pulley and then connects to a spring. The spring then hooks onto a bolt used as a post.

The details of one of the fences is shown below. When cutting foam, try to keep the feed speed constant as the kerf size varies with feed speed. The hotter the nichrome wire, the faster the feed speed can be and the larger the kerf is, and the more likely that the nichrome wire will break.

Box Design

The University of Maine High Altitude Ballooning Team has settled on a rectangular box. One box design has finished inside dimensions of about 4" x 4" x 4" cut out of the following pieces:

- 2 wide sides - 6" tall x 6" wide
- 2 narrow sides - 6" tall x 4" wide (string slot to be cut in these two pieces)
- 2 top & bottom outer plate - 6" x 6" wide
- 2 top & bottom inner plate - 4" x 4" wide

Of course, nearly any rectangular box shape and size can be used. The two narrower sides pieces will also have string slots cut in them. We pass a string through two long holes in the box sides to hold the payload box to the balloon flight system. A straw is stuffed into the string slot to reinforce the hole. Without a reinforced slot, the payload string would likely saw right through the box foam.

The box will also need plastic shoulder washers to reinforce the foam where the string exits the top and bottom outer plates. EconoKote will cover the outside of the boxes to provide a (more) durable exterior.

Box Construction

Cut out the pieces needed for the box. Use the fences to cut parallel and square pieces of the same size. A carpenter's square can be used to make perpendicular cuts.

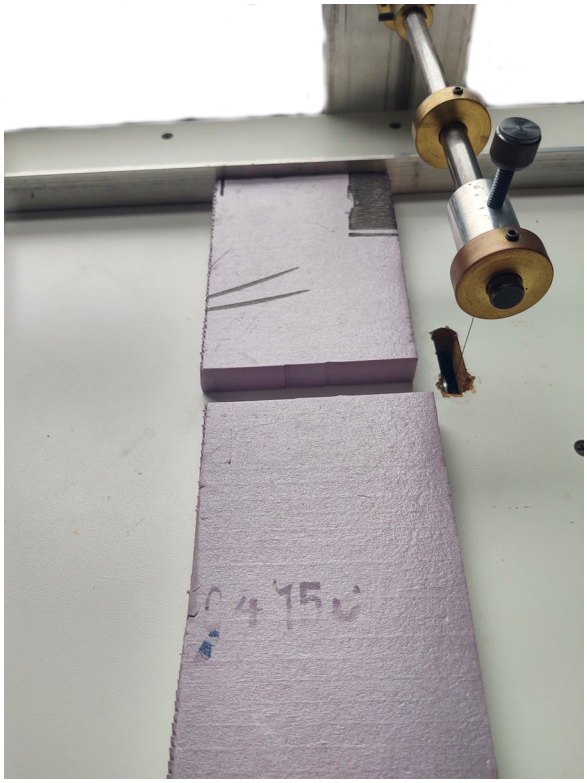
To make the string slots, we use a long stretched nichrome wire mounted on a board. This will be called the string slot cutter. Pass current through the nichrome wire to heat it and then place a side panel edge on the heated wire. Cut on one of the 6" narrow edges of the narrower side pieces.

The height of the nichrome wire above the wooden board is very important. Set the height

based on the foam thickness and desired string slot width. The formula is for the height of the nichrome wire above the wooden board, *Nichrome_Wire_Height* is

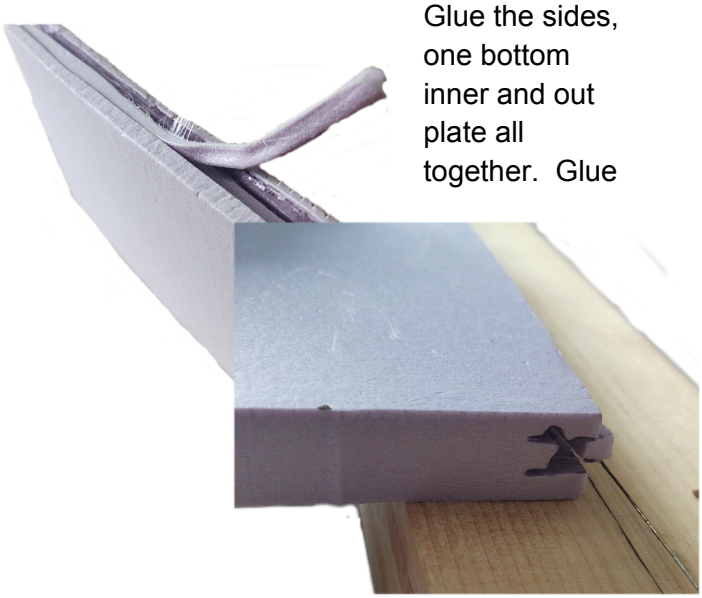
$$Nichrome\_Wire\_Height = \frac{Foam\_Board\_Thickness - String\_Slot\_Width}{2}$$

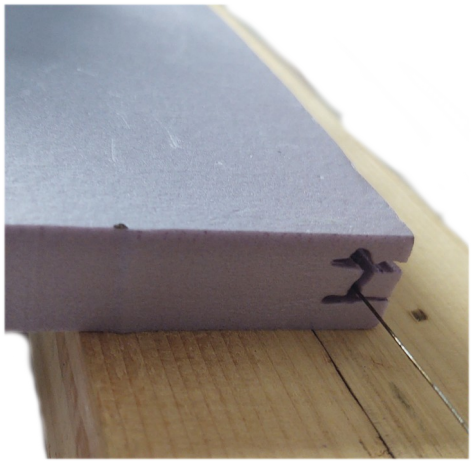
where *Foam_Board_Thickness* is the thickness of the foam board, *String_Slot_Width* is the width of the desired string slot. Give the string slot cutter a test and make adjustments before trying it on production work.



Place the large flat side of the narrow side piece on the wooden board of the string slot cutter. The 6" long side should be facing the nichrome wire. Gently slide the narrow side piece into the hot wire cutter. Cut into the foam about ⅜". Be sure the depth is the same on both ends of the narrow side piece. Then, turn off the current in the nichrome wire. Gently flip the narrow side piece over. Turn the current in the nichrome wire back on. Hold the piece in place until the hot wire cutter melts down to its nominal height. Finally, gently slide the narrow side piece such that the hot wire cutter will exit the foam board. In the slot, place a straw and check for fit. Make any adjustments as needed. Pull the long foam part that was just cut out of the slot.

Glue the sides, one bottom inner and out plate all together. Glue





the top inner and outer plates together to form a lid. Place a straw in the channels cut in the sides. Trim the straws as needed. Use weights and elastics to hold the pieces together while the glue cures. The straws will eventually be trapped by the top and bottom outer plates. They do not need to be glued as we have found that glue does not bond well to them.

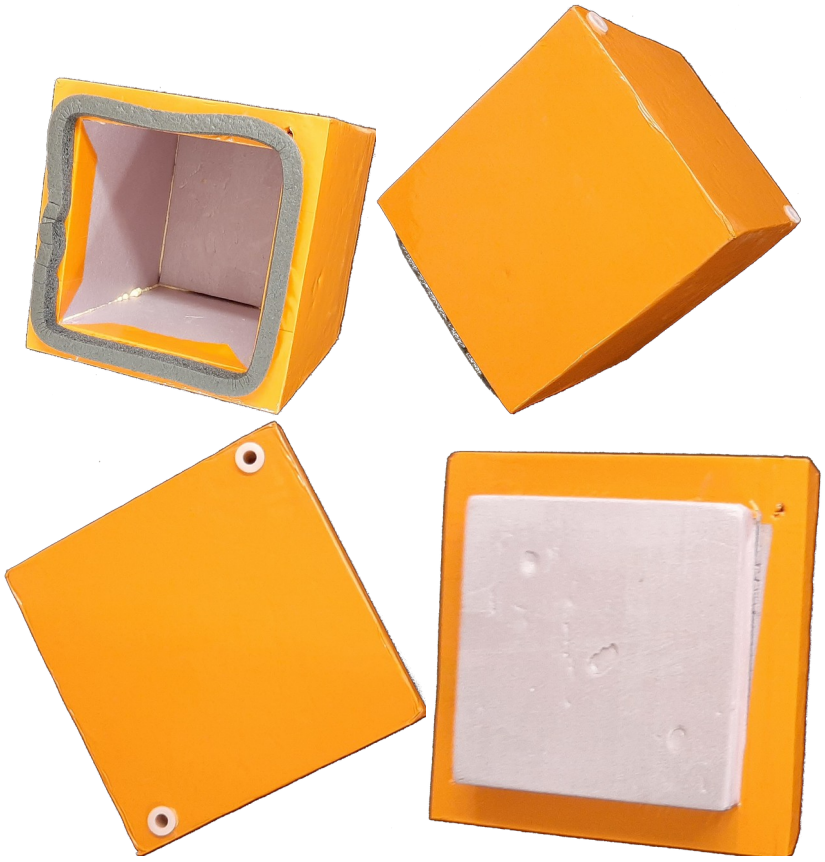
After the glue dries, use a sanding block to remove excess glue from the outside of the box. No need to worry about any glue on the inside of the box. Then, use a long straight, narrow, stiff wire to carefully poke pilot holes through the top (cover) and bottom outer plates.

Using the pilot holes as guides, carefully use an "L" drill

bit (probably can be done without a drill) to open the pilot holes in the bottom and top outer plates. Make the depth the same as the plastic shoulder washers.

Next, to make the boxes highly visible, orange EconoKote is cut and ironed on the outside of the box using a sealing iron. Coat both the box body and lid. Only the outside of the box needs EconoKote.

Place a foam seal on the top of the box sides. Poke holes through the EconoKote for the string.



Hot glue plastic shoulder washers in the top of the cover and bottom of the box.

Labeling

Be sure to label boxes with appropriate contact names and phone numbers in case the payloads are found by others. Using the standard NEBP labeling.