Laying out a Scale Model of a Hare Paenga (Boat House) Foundation from Easter Island (Rapa Nui) Activity

Supplies:

- 2 sheets of letter size (8.5 by 11 inches) paper
- Piece of Styrofoam, roughly the same size as the paper
- 2 small nails or straight pins or toothpicks
- 12 inches of string (non-stretchy)
- Scissors (optional)
- Ink pen or pencil

Introduction to hare paenga (boat houses) of Rapa Nui (Easter Island)

The Rapanui people of the island Rapa Nui, also known as Easter Island, at one time had a written script called Rongorongo. Unfortunately, the ability to read Rongorongo has been lost. So currently archaeology and oral tradition are the only available sources for information about the early people of the island. Oral tradition states that the houses originally had upside down canoes for their roofs, and thus they are called hare paenga, or in English, boat houses. The foundations of the boat houses are elliptical in shape, with the foci very close to the ends of the major axes. In this activity, we will investigate the shape of archaeological remains of the boat houses by constructing a scale model based on the definition of an ellipse.

(Left) Dr. Ximena Catepillán exiting a replica hare paenga. (Right) Archaeological remains of a stone foundation of a hare paenga. Photos by Dr. Cynthia Huffman, 2019, Easter Island.

Determine an appropriate scale

Based on 2019 drone images from Tukuh Technologies (https://www.tukuh.com/) several hare paenga stone foundations were roughly 40 feet long and 10 feet wide. Since we're going to be using a standard letter size sheet of paper (8½" by 11"), let's first convert to inches.

Step 1: 40 feet = _____ inches

Next let's find a nice scaling factor.

Step 2: List out the factors of your result from Step 1.

Step 3: When modeling with mathematics, we want to find a balance between being realistic while keeping the mathematics simple (or doable). So, looking at the factors you have listed above, pick one that would:

a. fit nicely on the paper
b. is likely to make the arithmetic come out nicely. Your choice _____

Step 4: A scaling factor is the ratio of the length of the model to the length of the actual object, using the same units. Using inches for our unit, our scaling factor is

$$\frac{\text{Step 3 answer}}{\text{Step 1 answer}} = \_\_\_\_\_$$

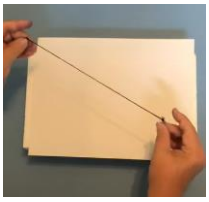
So 1 inch will represent _____ inches or _____ feet.

Step 5: Convert an actual measurement of 3 inches to the associated length using this scale. (Hint: the model length should be shorter than the actual length.)

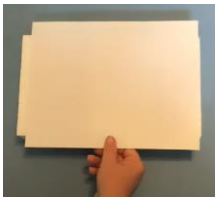
_____ inch represents 3 inches

Foundation model construction

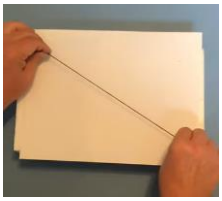
Step 1: Tie the piece of string to the 2 nails so that when it is stretched out taut, the nails are 10 inches (answer from Step 3 above) apart. Alternatively, tie two knots 10 inches apart in the string and then poke a nail through each knot. Use the scissors to cut off any excess string.



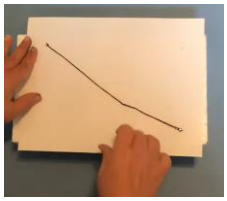
Step 2: Lay the 2 sheets of paper on the foam. (Two sheets are used to make it easier to draw the ellipse.)



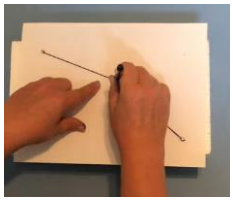
Step 3: Poke the two nails through the sheets of paper into the foam, so that the string is stretched tight with the nails 10 inches apart.



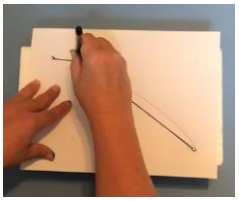
Step 4: Move each nail in towards the other $\frac{1}{16}$ inch and press into the foam. These 2 points will be the foci of the ellipse. Notice there is now some slack in the string.



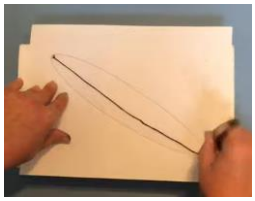
Step 5: Keeping near the paper, place the tip of the pen against the string and pull it so the string is taut.



Step 6: With the tip of the pen on the paper and perpendicular to the paper, and keeping the string taut, trace out one side of the ellipse.



Step 7: Repeat steps 5 & 6 to trace out the other side of the ellipse.



Step 8: Look up the definition of an ellipse and explain how this activity corresponds to the definition of an ellipse.

A video demonstrating the activity can be found at https://youtu.be/u8s-DG68fME.