

Engineering a Cardboard Boat

Ryan Germain and Erik Wolbach

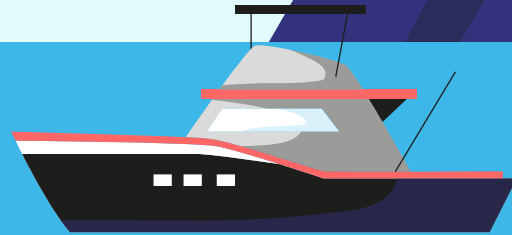


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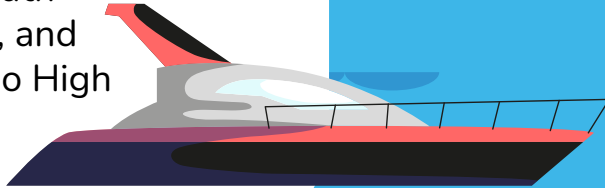
Questions



Ryan Germain

- 13 years of teaching experience
- PLTW - IED and PoE
- Electronics
- Fab Lab

- Worked at West Allis Central, South Milwaukee, and Mukwonago High Schools.



Erik Wolbach

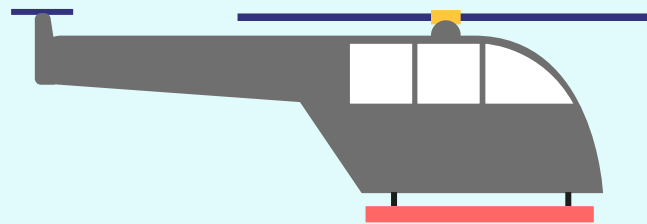
- 18 years of teaching experience
- Engineering
- Robotics
- Electronics
- Fab Lab

- Worked at South Milwaukee, and Union Grove High Schools.

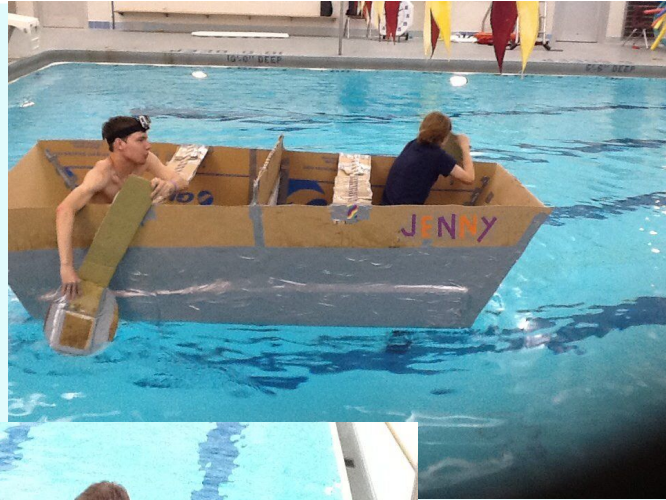
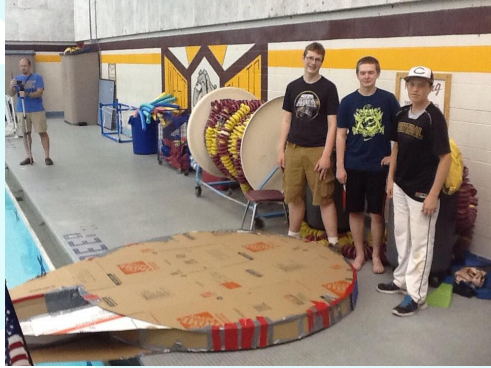
01

Origins

Our first couple of tries



Let's look back in time (Ryan)



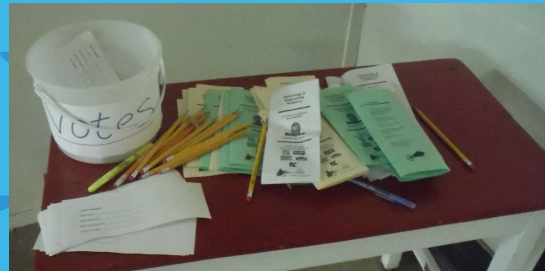
Let's look back in **time** (Erik)

- Started competition at South Milwaukee High School in 2014.
- Competition after school in high school pool. Attended by public, school board, admin, teachers, parents and students.
- Bracket style competition with double elimination.
- Team and boat names. Spirit wear encouraged.
- Created event program/brochure.
- Audience voted for some awards.
- Trophies given for 1st, 2nd, 3rd places, Best Design, Titanic Award, Submarine Award, Team Spirit.

Let's look back in time (Erik)



Let's look back in time (Erik)



Resources, What you need to get started

- ❖ Cardboard
 - Donated through Independence Corrugated
 - Manager said I could announce the company and you should contact them.
- ❖ Tape
 - Ordered through Amazon, nothing special, I usually go cheap (clear Packaging Tape)
- ❖ Cutting tools
 - Box cutters and strong scissors work
 - Canary cutter. Absolute best device for cutting
 - Straight edges for folding
- ❖ Pool/Lake
 - YMCA was very accomodating.
 - Need Busses with the handicap entrance to load boats on a school bus



Resources, continued

- ❖ Transportation
 - Utilize Army National Guard Trailer pulled by recruiter who is a supporter of our engineering and robotics programs.
 - Borrow Robotics trailer or parent vehicles.
 - Bus with handicap entrance
- ❖ Disposal
 - Arrange for use of dumpsters on site to throw out used boats.
 - Arrange for school custodians to load and transport to dump.
- ❖ Prototype Model Building
 - Manilla Folders and Scotch Tape
 - Blue Painters Tape
 - Oil Based Clay
 - Water bin with graduated cylinders
- ❖ Pool Items
 - Paddles, horn or whistle, timing device
 - Clip boards, schedule of races displayed.

Vision




Our Vision is to bring together students and community members in a fun and creative challenge, fostering teamwork, innovation, and building a sense of community through friendly competition.



Brainstorming

Brainstorm: Select three different *styles* of boats and determine their characteristics using a Google search.

ENG2.a.8.h: Analyze the process of engineering design accounts for a number of factors to make decisions.

	Karvel/carvel	Yacht	Speed boat
Picture			
Main Purpose	It moves through shallow waters easily, so it was used for war and more common purposes like moving goods, especially across shallow waters like rivers.	A yacht is usually used for pleasure, cruising, or racing. Usually though, people mostly hear about cruises or parties on yachts today.	The purpose of a speed boat is to travel very fast; usually for racing or for cruising around a body of water.
Speed	Since the carvel is smaller than most boats, it is able to go faster. Very fast considering they did not have engines	40-60 knots is the top speed of a normal yacht.	122 mph is the top speed for a speed boat and most can usually hit around 100 mph.
	This boat is made for	Not quite as good as yachts	A speedboat is fairly maneuverable because it

Introduction: Students brainstorm some ideas, doing research on boat types and the advantages of each type.

Investigations

Investigation #1

Explore Possibilities: How many pennies does it take to sink an aluminum foil boat?


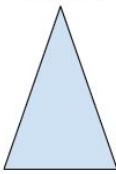
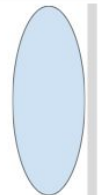
Objective: As a result of the investigation, you will be able to determine how much area you will need to support the weight of the rowers in your boat.

ENG3.a.7.h: Research and development is a specific problem-solving approach that is used intensively in business and industry to prepare devices and systems for the marketplace.

Directions:

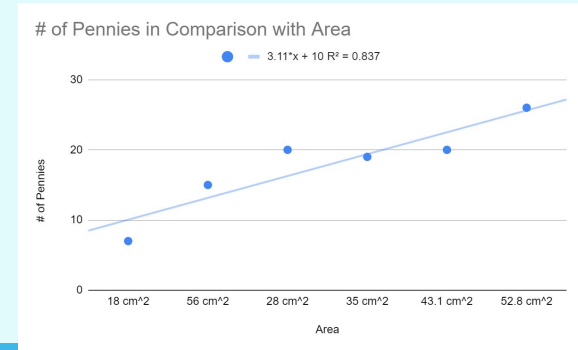
1. Construct *three* different flat-bottom boats, each using a single sheet of 6in x 6in aluminum foil. The height (sides) of each boat should be a 1/2 inch.
2. Calculate the area of the bottom of each boat; record your calculations in **Table 1** below.
3. Predict the maximum number of pennies each boat will support; record your predictions in **Table 1** below.
4. Determine the maximum number of pennies the boat can support *before* sinking; record your findings in **Table 1** below.

Table 1: Individual Data

	Boat #1	Boat #2	Boat #3
Drawing of Shape	 Boring Boat	 Pizza Boat	 Cool Boat
Area (cm ²)	52.8 cm ²	35 cm ²	43.18875 cm ²

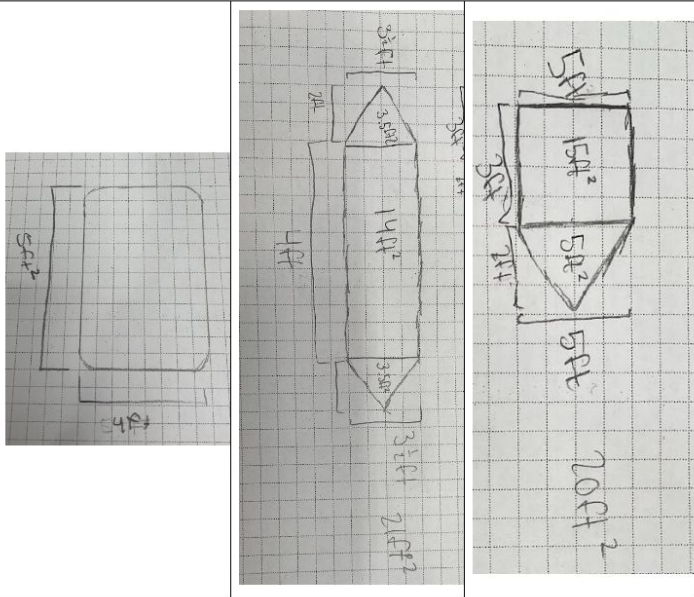
A series of investigative parts will help students to understand the relationship between surface area the weight that can be supported

This experiment uses data (trendline) to predict data

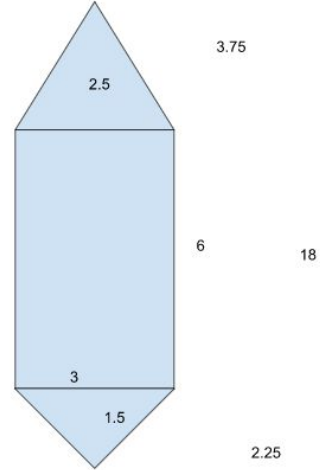


Determining Volume

Engineering Design Challenge: Boat



Directions: Select the design you and your partner intend to construct, taking into consideration the engineering design challenge objectives and constraints. Using masking tape, to mark the outline for the design area. Then, sit in the outline of your boat's area to ensure you and your partner fit comfortably. Upload a photo of your boat's outline in the space provided below.

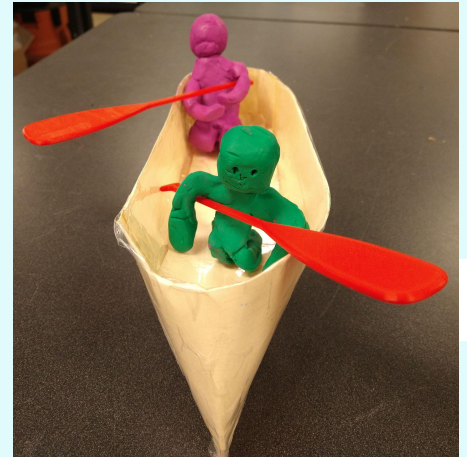
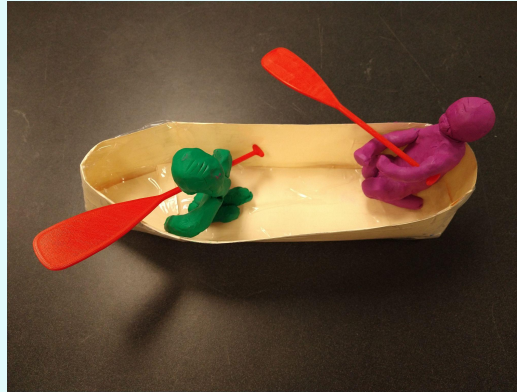
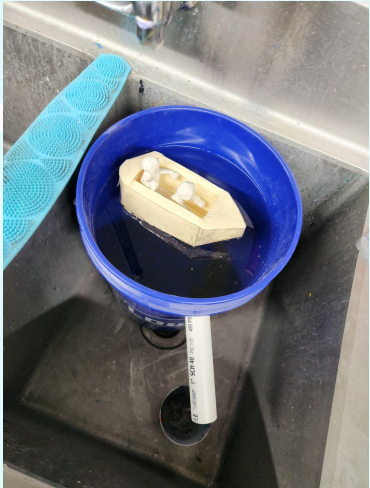


4 in fold over on bottom piece



Clay models

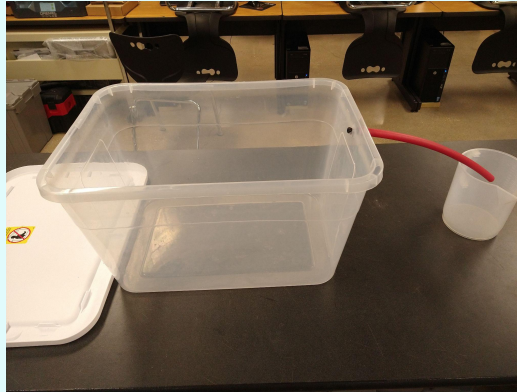
- Built 1/10th scale boats
- Manilla folders and Scotch tape
- Clay models of rowers to 1/10th scale
- 3D printed oars to demonstrate side height



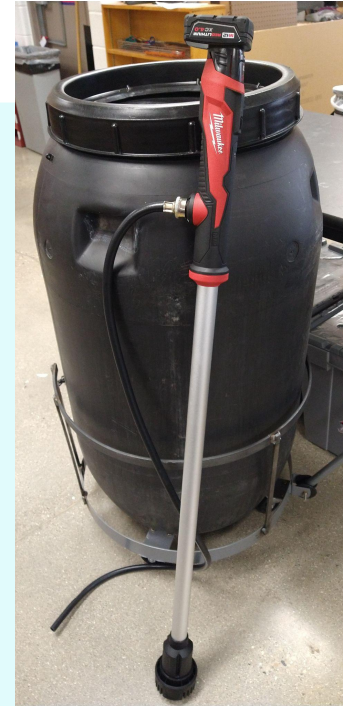
Testing Prototypes



Water Trough Testing

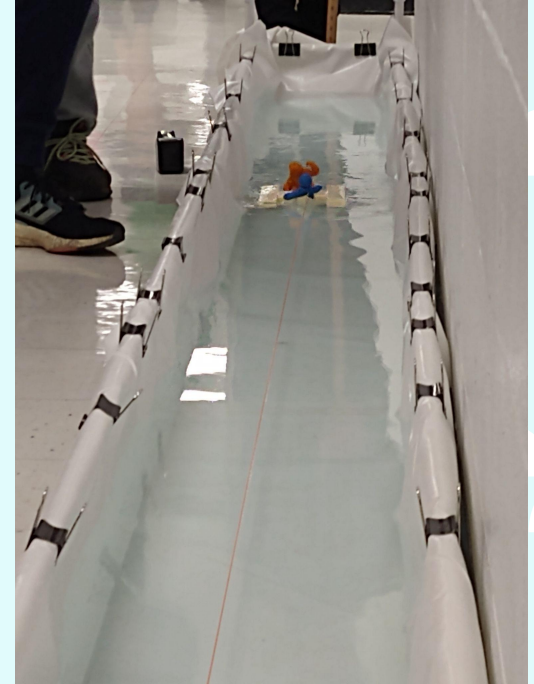
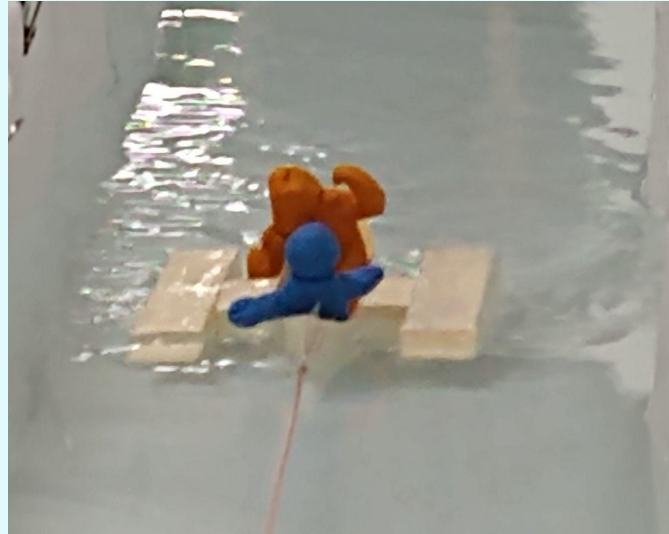
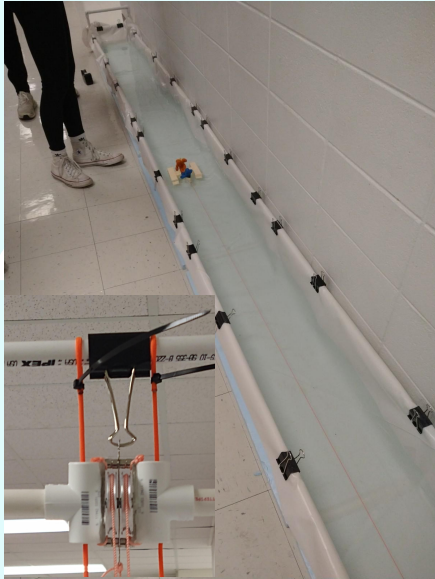


Buoyancy and
Displacement Testing



Rain barrel \$175
Transfer Pump \$200

Clay models



Self fabricated system using PVC, rigid foam insulation, heavy plastic sheet, binder clips, pulleys and string. Cost \$350.

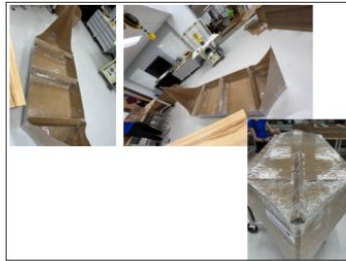
Testing / Building

STEP 6

Test/Evaluate the Design

Introduction: In this section you will physically be creating your boat and preparing it to go into use.

Test/Evaluate the Design: Use this space to take notes on your building process. What do you plan on doing? What have you tried? What worked and what did not work?

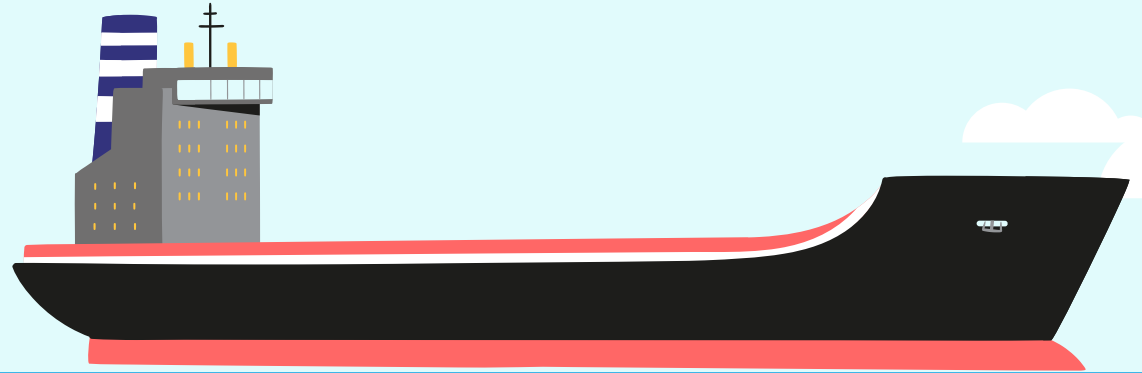


We planned on making a viking type boat that had bows that were very pointed upwards. While constructing the boat, we were very successful with completing the boat in the way that we wanted. However, we struggled when we were alone and didn't have another person to hold the boat while we taped. Also, we also had to add more overlapping pieces to our boat than originally planned because the length of the cardboard given was shorter than we needed. Overall though, we found that we were successful with implementing our plan for our boat and found that it worked well when testing it. We added a lot of tape to ensure this. In general, the look and functionality of our boat was completed well.



Advertising for your program

<https://www.cbs58.com/news/local-high-school-engineering-students-create-cardboard-boats-to-float-on-water>



Advertising for your program

<https://www.fox6now.com/sports/winning-the-race-takes-more-than-just-athletic-prowes>

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Communication

STEP 7

Communicate Results

ENG4.c.6.h: Evaluate final solutions and communicate observation, processes and results of the entire design process, using verbal, graphic, quantitative, virtual and written means, in addition to design models.

Mukwonago High School



Communicate Results: _____/20
Engineering Design Challenge: Boat

Create a Google Presentation summarizing your entire process. Be sure to include a slide about the problem, your research, the possibilities you explored, your design proposal, and the testing/evaluation of boat. Include pictures taken throughout the process and sketches. Reflect on the project while hitting on what went well and what you would do differently if given another chance.

Project parts



Tips and tricks

- A flat bottom is recommended. A V-shaped bottom is likely to tip over unless the V is very gentle.
- The lowest center of gravity is the most stable. Kneeling or standing will cause you to tip over.
- Longer boats go faster, but they are harder to turn.
- Boats shorter than 10 feet are difficult to steer.
- For height, allow about 18 inches for you to sit and paddle effectively without the edge of your boat blocking your arms.
- Figure about 30 inches maximum for 1 person, 48 inches for two people.
- Clear tape melts when it is painted.
- Forget about “glue guns” because that type of glue melts on hot days.
- Fold a lot and cut sparingly.

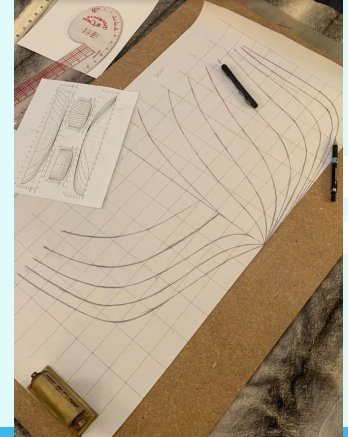
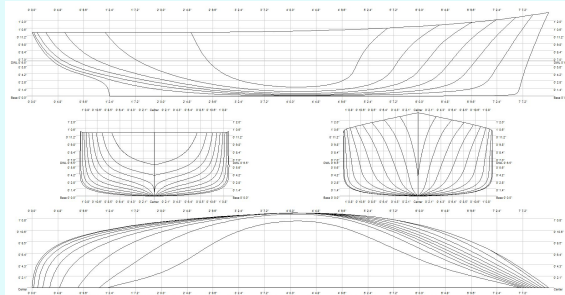
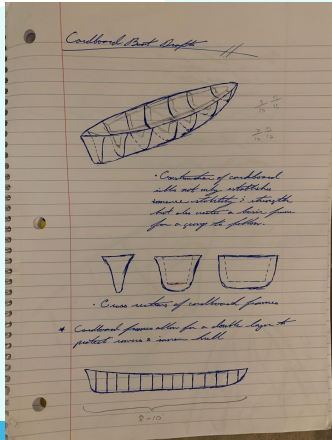
**Always have
more tape**

Have fun

Keep it simple

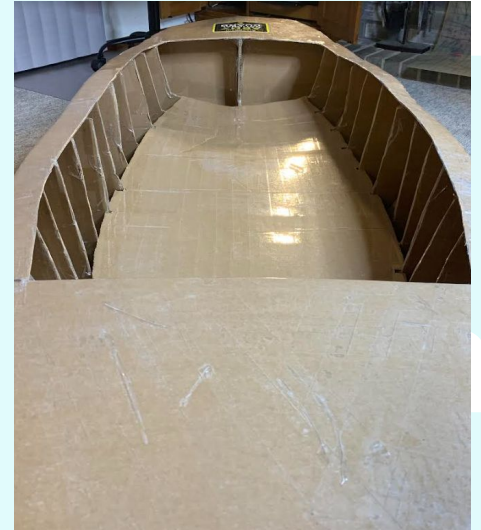
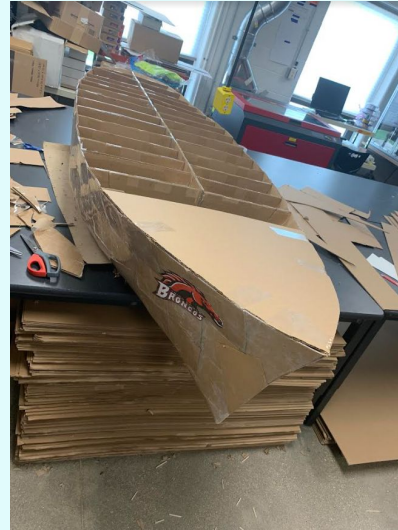
Taking it further, way further

- Ryan Miller used Free!ship Plus design software to create the shape of the boat to include the ribbed structure inside.
- Translated design into Adobe Illustrator files used by the Universal laser engraver to cut out the small internal cardboard parts.
- Assembled inside structure first and then added outside and waterproofing.

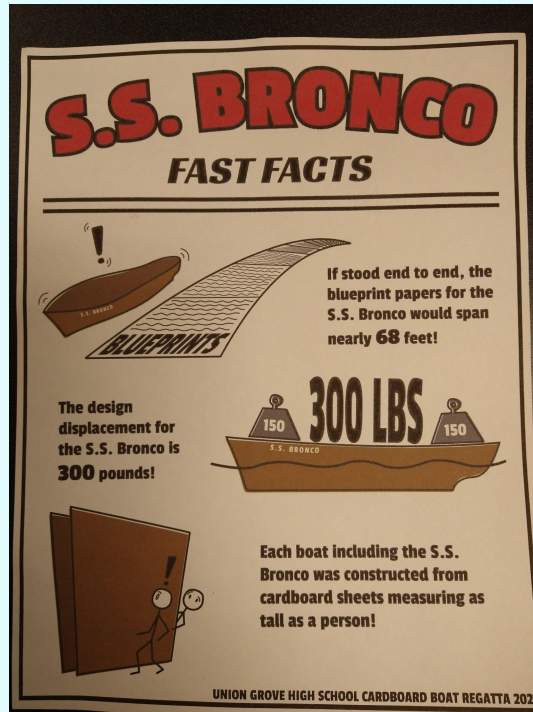


Taking it further, way further


- Assembled inside structure first and then added outside and waterproofing.



Taking it further, way further

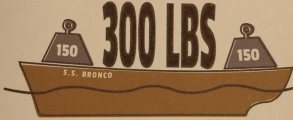


S.S. BRONCO
FAST FACTS




If stood end to end, the blueprint papers for the S.S. Bronco would span nearly **68 feet!**

The design displacement for the S.S. Bronco is **300 pounds!**



300 LBS

Each boat including the S.S. Bronco was constructed from cardboard sheets measuring as tall as a person!



UNION GROVE HIGH SCHOOL CARDBOARD BOAT REGATTA 2022

Questions / Contact US

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