THE EDUCATION FUND

FOR EXCELLENCE IN MIAMI-DADE PUBLIC SCHOOLS

2019-2020

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Wind Tunnel Engineering

High School Physics Labs

Wind Tunnel Engineering

Rebeca G. Hernandez

Of Dade County Public Schools, in collaboration with

FIU School of Engineering Wall of Wind STEAM activities

Table of Content

Introduction

HISTORY

Wind tunnels exist to study complex aerodynamic tunnels have been created in many styles and sizes, with their designs governed by the overall aerodynamics. Since the mid-twentieth century, wind tunnel testing has become the primary method for establishing wind loading provisions used in building codes and standards. Typically, scaled models and/or section models of a large structure are tested in the wind tunnel, allowing details such as the structure's shape, location, and surrounding terrain to be considered.

RECENT RESEARCH / WORK

Wind engineers investigate the interaction between wind and the natural and built environments by combining knowledge from several disciplines, including structural engineering, mechanical engineering, meteorology, and applied physics. Hurricanes and tornadoes can inflict major damage to entire communities.

NSF NHERI Wall of Wind (WOW) Experimental Facility (EF) at Florida International University (FIU) was funded by NSF to be a national facility that enables researchers better understand wind effects on civil infrastructure systems and prevent wind hazards from becoming disasters. The facility has a 12-fan system capable of repeatable testing wind speeds in up to 157 mph; simulation of the effects of wind and wind driven rain up to category 5 Hurricane wind speeds

I was part of a research experience for teachers in collaboration with Dade County Public Schools. As a result, Jorge Barroso (another physics teacher) and I spent 5.5 weeks working with graduate students, learning about several projects that were being implemented at the WOW, figuring out how to convert what we learned into activities that can be done in high school physics, creating a road map and curriculum for Florida schools, and planning for our "West" Professional Development that we would teach to other teachers for three days. This report features two of the labs that we created originally and modified by me for my class room.

IN THE CLASSROOM

The Portable wind tunnel model that can be reproduced in your class room was originally created by students working for FIU School of Engineering for the Engineers on Wheels Program. This is an initiative which brings FIU engineering students to South Florida K-12 schools. WOW provides teachers with hands-on activities and engineering experiments while exposing them to career opportunities in STEM (science, technology, engineering and math).

This Packet contains several lab activities that were modified by me to have students interact, collaborate, and explore a side of science and technology that most have never done before. Students explore the effects of wind inside a portable wind tunnel model. They build a house, a set of traffic lights, or a set of two FPL towers with recycled materials place those structures inside the wind tunnel test chamber and have a fan at several settings produce winds that hit your structure. Students then describe, draw, and explain their observations. Students also use Anemometers (measure wind speeds) and Manometer & a Pitot Tube (measure air pressure) inside a portable wind tunnel in the class room very similar to the one of WOW Engineers on Wheels. They take real time data and compare them to calculations using Bernoulli's equation and the Continuity equation which deal with applications of conservation of mass and energy. Doing this wind tunnel will enhance students' understanding of flow types (laminar vs. turbulent), flow patterns around different objects, the conservation of mass and conservation of energy (Bernoulli's equation) principles, aerodynamic lift and drag, and how wind interactions affect our daily lives.

Portable Wind Tunnel Dynamic Pressure and Velocity Analysis of Bernoulli's & Continuity Equations

When wind encounters an obstacle, it acts onto it and around it. This wind can cause damage onto a structure. Mitigation of wind damage onto any building is obtained via research of wind interactions using FIU's Wall of Wind (WOW) experimental facility. Acquisition of data is through the vast sensor network that is connected to a human interface computer system in a control room. You will mimic this procedure in the class room.

In this experiment, you will use a Pitot Tube, a digital Anemometer, a digital Manometer, and built models to be placed inside the portable wind tunnel. Obtain data by placing the instruments at various places inside the wind tunnel with and without any built structure models. Analysis of the average pressures and wind speeds are inserted into equations and compared as analysis.

BENCHMARKS

SC.912.P.12.1

Distinguish between scalar and vector quantities and assess which should be used to describe an event.

SC.912.P.12.2

Analyze the motion of an object in terms of its position and velocity as a function of time.

SC.912.P.12.3

Interpret and apply Newton's three Laws of Motion.

SC.912.P.12.5

Apply the law of conservation of linear momentum to interactions, such as collisions between objects.

SC.912.P.5.2

Kinetic Energy (organization of matter)

SC.912.P.10.1

Differentiate among the various forms of energy and recognize that they can be transformed from one form to others.

SC.912.P.10.2

Explore the Law of Conservation of Energy by differentiating among open, closed, and isolated systems and explain that the total energy in an isolated system is a conserved quantity.

OBJECTIVES

- Explore the effects of wind inside a portable wind tunnel model.
- Obtain wind velocity data using a digital anemometer.
- Obtain wind pressure data using a digital manometer.
- Calculate cross sectional areas where data is to be obtained in the wind tunnel.

- Calculate wind pressure using Bernoulli's equation from data obtained in the wind tunnel.
- Calculate wind velocity using Continuity equation from data obtained in the wind tunnel.
- Compare calculated values to data obtained.

HYPOTHESIS

State your claim, in an "if", "then" statement.

MATERIALS

Portable Wind Tunnel Model	Calculator
Pitot Tube	Digital Manometer
Excel Data Table	Digital Anemometer

PROCEDURE

- Obtain the room temperature
- Obtain the barometric pressure in the room.
- Measure the two cross sectional areas where instrumentation is to be placed (where the pressure readings and velocity readings are taken with instrumentation.
- Obtain the average two pressure measurements using Manometer
- Obtain the average two velocity measurements using digital Anemometer (facing the fan winds).
- Calculate the wind velocity using the modified Bernoulli's equation (v1)
- Use the Continuity Equation to find the wind velocity (v1)
- Compare answers two real data and obtain percent error.

PRELIMINARY QUESTIONS/DESCRIPTIONS

1. Consider high winds hitting the side of a building. At what wind speed(s) do you think that the building will begin to brake?
2. At what pressure(s) do you think that the structure(s) will begin to brake?
3. How can wind pressure patterns be analyzed?
4. How can speeds/velocities from wind patterns be obtained?
5. How can we mitigate against structural damage of high winds?
6. How can wind effects patterns onto modeled structures be analyzed?
7. How can forces from winds affect real life structures?
8. How can we mitigate against structural damage of high winds?

DRAWINGS OF SET UP (ON SEPARATE SHEET)

DATA

Bernoulli	(all P readings in kPa)					
Trials	ΔP	t(s)	V (m/s)	V_2 (m/s)	P_1	P2
1 2 Ave.:						

Continuity Equation						
Trials	A1 (m²)	V1 (m/s)	ρ1	A1 (m²)	V2 (m/s)	ρ2
1 2 Ave.:						

FORMULAS / THEORY

Bernoulli's Principle

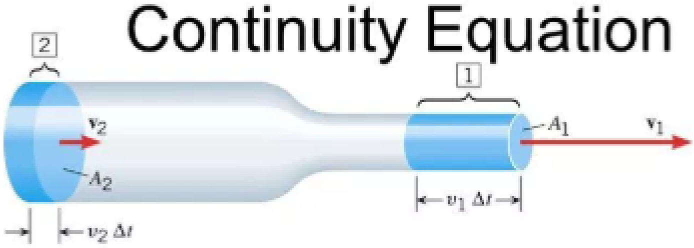
Theory - Equation

$$P_1 + \frac{1}{2}\rho V_1{}^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho V_2{}^2 + \rho g h_2$$

Where (in SI units)

P= static pressure of fluid at the cross section
ρ= density of the flowing fluid
g= acceleration due to gravity;
v= mean velocity of fluid flow at the cross section
h= elevation head of the center of the cross section with respect to a datum.

Continuity Equation



$$\rho_2 A_2 v_2 = \rho_2 A_1 v_1$$

Same, incompressable, fluid so roe drops out!

$$A_1 v_1 = A_2 v_2$$

CALCULATIONS

Using Bernoulli's Equation: h = ______ m, (measured height, does not change)

g = ______ 9.81 m/s² (acceleration of gravity constant)

v = 2 (P) / ρ (velocity found from rearranging Bernoulli's and inserting Pressure data)

then

v = $\sqrt{2\,(P - P)/\rho}$ (taking the difference in pressures and dividing by density)

Using Continuity Equation:

$$\boxed{\rho_2 A_2 v_2 = \rho_2 A_1 v_1}$$

Obtain the final velocity and compare to Bernoulli calculation and the real data obtained with the equipment.

Note: Obtain the temperature, barometric pressures, and air density values of the days taking measurements via the internet.

ANALYSIS / OBSERVATONS / RESULTS

1. Describe your observations.
2. Draw your observations, including the wind hitting your structure(s), specifically where the winds affect the structure(s).
3. Explain your results.

CONCLUSION (STEAM OR ENGINEERING)

1. State whether your hypothesis was correct or incorrect.
2. What basic, fundamental law / scientific principle is behind your reasoning for your stated claim / hypothesis for your data / observations are evident?
3. Suggest a new research question or a new hypothesis
4. Suggest a new way to modify the experiment.

EXTENSIONS (STEAM OR ENGINEERING)

5. Use smoke to visualize the flow around different objects.
6. Use smoke to visualize vortex shedding.
7. Investigate the uplift on various roof shapes (flat, gable, hip).
8. Investigate the lift and drag of an airfoil.
9. Design an airfoil to optimize the lift-to-drag ratio.
10. Design a vortex suppression device to reduce uplift on a flat roof.

Portable Wind Tunnel Dynamic Analysis of Structures

When wind encounters an obstacle, it acts onto it and around it. This wind can cause damage onto a structure. Mitigation of wind damage onto any building is obtained via research of wind interactions using FIU's Wall of Wind (WOW) experimental facility. Acquisition of data is through the vast sensor network that is connected to a human interface computer system in a control room.

In this experiment, you will place built models inside a portable wind tunnel. Obtain observations by placing the instruments at various places inside the wind tunnel with and without any built structure models. Analysis of the average pressures and wind speeds are inserted into equations and compared as analysis.

OBJECTIVES

- Explore the effects of wind inside a portable wind tunnel model.
- Build a house, a set of traffic lights, or a set of two FPL towers with recycled materials
- Place your built structure inside the wind tunnel test chamber and have a fan at several settings produce winds that hit your structure
- Describe your observations
- Draw your observations, including the wind hitting your structure
- Explain your results

PROCEDURE

- Build a house, a set of traffic lights, or a set of two FPL towers with recycled materials
- Place your built structure inside the wind tunnel test chamber
- Have your partner start the fan on the first setting
- If the structure is not broken or damage, then redo the last step at setting number two.
- If the structure is not broken or damage, then redo the last step at setting number three.
- Describe your observations
- Draw your observations, including the wind hitting your structure
- Repeat test steps at 45˚ angle and at 90˚ angle.
- Describe your observations
- Draw your observations, including the wind hitting your structure
- Explain why your structure was able to stand or broke when the wind hit it and at which angle(s) this happened.

HYPOTHESIS

State your claim, in an "if", "then" statement.

MATERIALS

Portable Wind Tunnel Model	Glue gun & sticks
Foam boards	X-acto knife
scissors	ruler

PRELIMINARY QUESTIONS/DESCRIPTIONS

1. Consider high winds hitting the side of a building. At what wind speed(s) do you think that the building will begin to brake?
2. How can wind effects patterns onto modeled structures be analyzed?
3. How can forces from winds affect real life structures?
4. How can we mitigate against structural damage of high winds?

DRAWINGS OF CONTOUR LINESE

(on separate sheet)

ANALYSIS

1. Describe your observations.
2. Draw your observations, including the wind hitting your structure(s), specifically where the winds affect the structure(s).
3. Explain your results.

CONCLUSION (STEAM OR ENGINEERING)

1. State whether your hypothesis was correct or incorrect.
2. What basic, fundamental law / scientific principle is behind your reasoning for your stated claim / hypothesis for your data / observations are evident?
3. Suggest a new research question or a new hypothesis
4. Suggest a new way to modify the experiment.

EXTENSIONS (STEAM OR ENGINEERING)

1. Use smoke to visualize the flow around different objects.
2. Use smoke to visualize vortex shedding.
3. Investigate the uplift on various roof shapes (flat, gable, hip).
4. Investigate the lift and drag of an airfoil.
5. Design an airfoil to optimize the lift-to-drag ratio.
6. Design a vortex suppression device to reduce uplift on a flat roof.

WIND TUNNEL 2 SAMPLE LESSON PLANS

Lesson Plan: Wind Engineering | **Teacher:** Rebeca Hernandez & Jorge Barroso | **Date:**

Objective (s):

SC.912.P.10.1: Differentiate among the various forms of energy and recognize that they can be transformed from one form to others.
Remarks/Examples: Differentiate between kinetic and potential energy. Recognize that energy cannot be created or destroyed, only transformed. Identify examples of transformation of energy: Heat to light in incandescent electric light bulbs

SC.912.P.10.2: Explore the Law of Conservation of Energy by differentiating among open, closed, and isolated systems and explain that the total energy in an isolated system is a conserved quantity.
Remarks/Examples: Use calorimetry to illustrate conservation of energy. Differentiate between the different types of systems and solve problems involving conservation of energy in simple systems (Physics).Explain how conservation of energy is important in chemical reactions with bond formation and bond breaking (Chemistry).

Cognitive Complexity: Level 2: Basic Application of Skills & Concepts

Cognitive Level: High

Student(s) Should be able to:

- Build a working wind tunnel (from components provided)
- Take measurements to prove conservation of Energy applied to Fluid Dynamics in a model wind tunnel
- Measure velocity & pressure at various position inside a wind tunnel model
- Make calculations & prove the Continuity Equation & Bernoulli's Principle
- Describe Conservation of energy as it applies to a wind tunnel

Next Generation SSS Standard(s):

Standard 1: Practice of Science
ScC.912.N.1.1
SC.912.N.1.2
SC.912.N.1.5
SC.912.N.1.6
Standard 3: The Role of Theories Hypotheses, and Models
SC.912.N.3.5
Standard 10: Energy
SC.912.P.10.1
SC.912.P.10.2

Agenda: (sequence of class activities)

I. Demo
II. Lecture
III. Measurements
   A. Velocity with Anemometer
   B. Pressure with Manometer & Pitot Tube
IV. Calculations
   A. Using Continuity Equation
   B. Using Bernoulli's Equation
   C. Obtain:
      1. Velocity values
      2. Pressure values
V. Home Learning:
   A. Lab write up – finish it
   B. Work on CRISS 3-column style vocabulary
   C. Work on CRISS style Formula Booklet (foldable)
   D. Work Practice Problems – due following week

Strategies:
Class Discussion
Lecture
Demonstration
Group work
Individual Instruction
CRISS vocabulary
CRISS equation modeling

Assessments:
Observation
Paper
STEM model building
Lab process

Daily Physics Strategies/ Routines:

(pacing guides)
Modeling pedagogy
Socratic dialogue
white-boarding
inquiry
cooperative groups

VAKT
Visuals, hands on
Small groups sharing
Clustering problems
Report writing
drawing

Lab Data Activity:

Lab:
Dynamic Pressure and Velocity Analysis inside a Portable Wind Tunnel Model

Extech HD 755	(all P readings in kpai) Bernoulli's Principle					
Trials	ΔP	t(s)	V (m/s)	P1	V (m/s)	P2
1						
2						
3						

Using Bernoulli's Equation: h = constant
g = constant

$$P_1 + \frac{1}{2}\rho V_1^{\,2} + \rho g h_1 = P_2 + \frac{1}{2}\rho V_2^{\,2} + \rho g h_2$$

$$V = \frac{2\,(\Delta P)}{\rho}$$

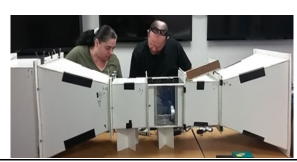
$$v = \sqrt{2\,(P - P)/\rho}$$

Extech HD 755	Continuity Equeation					
Trials	A1 (m²)	V1 (m/s)	ρ	A1 (m²)	V1 check	V2
1						
2						
3						

Using Continuity Equation:

$$\rho_2 A_2 v_2 = \rho_2 A_1 v_1$$

Vocabulary:
Pressure
Pressure difference
Pressure Taps
Coefficient of Pressure
Pitot Tube
Force
Fluid flow
Velocity
Bernoulli's Equation



Continuity Equation
Conservation of Energy
Work
Venturi effect
Venturi tube
Laminar flow
Turbulence

ESE / ESOL / SPED:
Log Journal
Word Wall /under TV
sharing VAKT
Report Writing
Concept Building
Small Groups

PROJECT PLAN: WIND ENGINEERING	TOPIC: WIND MITIGATION OF BUILDINGS	Subject: Aerodynamics of sustained high winds at different angles
Enter your concept map of unit idea here	TEACHER	Rebeca G. Hernandez Jorge Barroso
Hands-on building of wind tunnel and house models tested under high speed winds conditions to obtain qualitative and quantitative measurements for the understanding of aerodynamics and wind interactions onto these structues for mitigation of such structures.	GRADE	10, 11, & 12

KEY LEARNING(S)	UNIT ESSENTIAL QUESTIONS	OPTIONAL INSTRUCTIONAL TOOLS
Speed measurements Pressure measurements Pressure gradient obtained from calculations Force, moments, and torque analysis due to wind interaction onto structures.	How can a structure be built and mitigated to withstand sustained, high speed winds? What kinds of pressure measurements are recorded when sustained, high speed winds are applied to a building/structure? What effects do sustain, high speed winds have onto flat, gable, and/or hip roofs? What effects do sustain, high speed winds have onto traffic lights? What effects do sustain, high speed winds have onto power lines? How can different types of roofs be mitigated to withstand high speed wind pressures and forces?	WOW scaled down model Portable wind tunnel. Various sensors, system acquisition devices, & computers Model structures built by students. Various recycled materials.

CONCEPT #1	CONCEPT #2	CONCEPT #3	CONCEPT #4
Motion, inertia, speed, velocity, & acceleration	Force	pressure	Moments, torque
LESSON ESSENTIAL QUESTIONS #1	**LESSON ESSENTIAL QUESTIONS #2**	**LESSON ESSENTIAL QUESTIONS #3**	**LESSON ESSENTIAL QUESTIONS #4**
How can we build a structure that can withstand high winds speeds?	How do high, sustained winds act on a building? What force interactions occur when high speed winds interact with a building?	What pressures from wind interactions occur with high wind speeds around a building?	How do forces and pressures do to wind interaction cause damage to buildings?
VOCABULARY #1	**VOCABULARY #2**	**VOCABULARY #3**	**VOCABULARY #4**
Motion, inertia, speed, velocity, & acceleration vectors	Force, momentum, area	Pressure, force, area, pressure gradient, contour lines	Moments, torque

ADDITIONAL INFORMATION

- Different styles of wind tunnels are applicable
- Models of wind tunnels can only yield qualitative information
- Real data is acquired from expensive sensors and in extremely large quantities
- Sensors are positioned according to average wind damage areas

GENERAL WIND TUNNEL SAMPLE LESSON PLAN

<table>
<tr><td colspan="2">Lesson Plan: Wind Engineering</td><td>Teacher:</td><td>Date:</td></tr>
<tr><td><u>Objective (s):</u></td><td><u>Student(s) Should be able to:</u></td><td colspan="2"><u>Next Generation SSS Standard(s):</u></td></tr>
<tr><td><u>Agenda: (sequence of class activities)</u></td><td><u>Strategies:</u>
_A/V Materials _Board work _Class Discussion
_Demonstration _Group work_ ESOL_ ESE_EOC
_Lecture _Library Assignment _Review_ DATA chat
_Silent Reading _Student Presentation _FCAT
Individualized Instruction EOC_ CRISS/reading
<u>Assessments:</u>
_paper _observation _Class Work _Internet
_Quiz _Test (exam)_Research Project
__Lab _Student Presentation _Research Project
Board Builder Project Technology Software
_Excel Printout _Research Project
_Vernier Printout _Student Research Poster</td><td colspan="2">Daily Physics Strategies/ Routines:
<u>(pacing guides)</u>
Modeling pedagogy
Socratic dialogue
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cooperative groups</td></tr>
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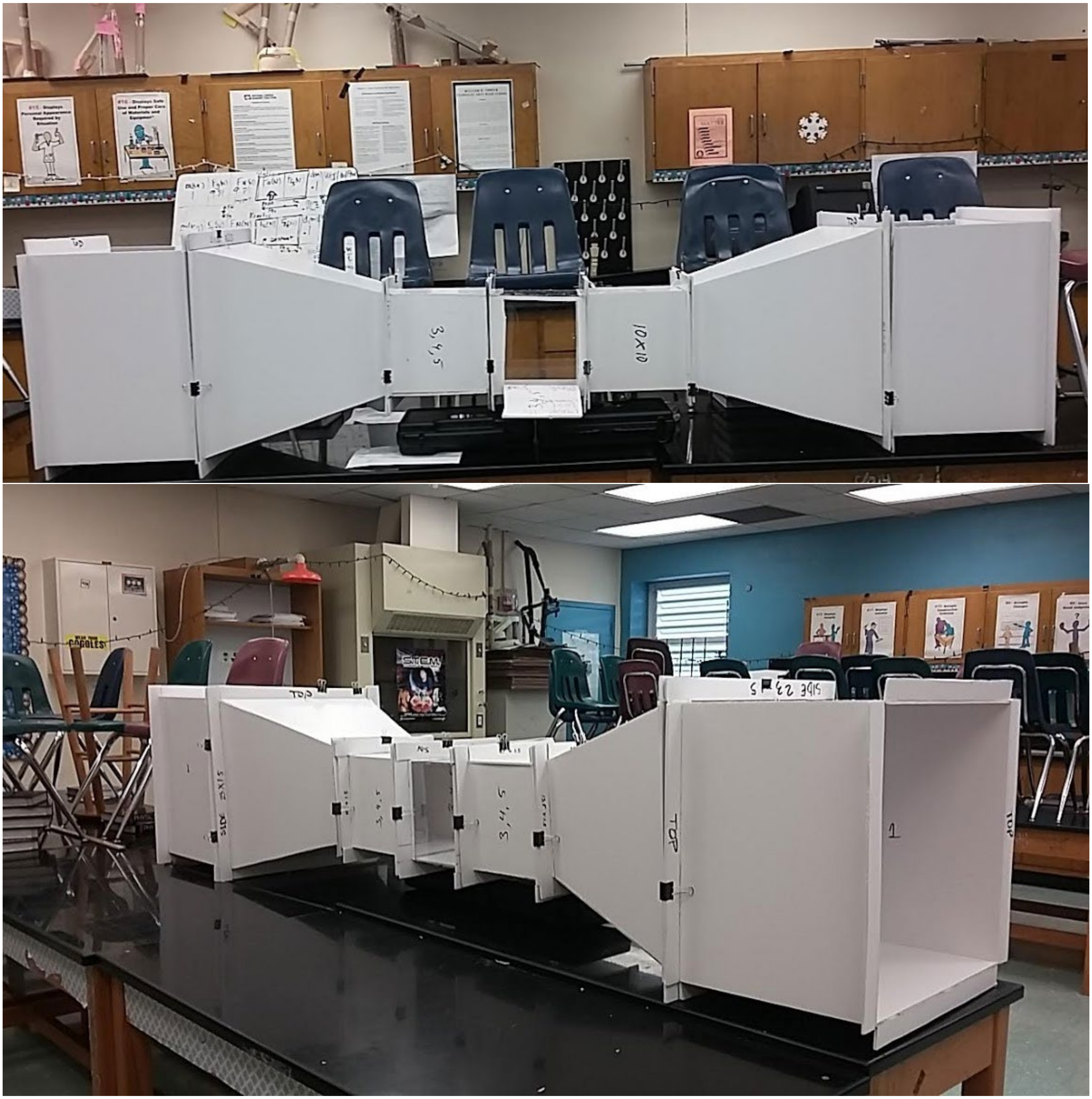
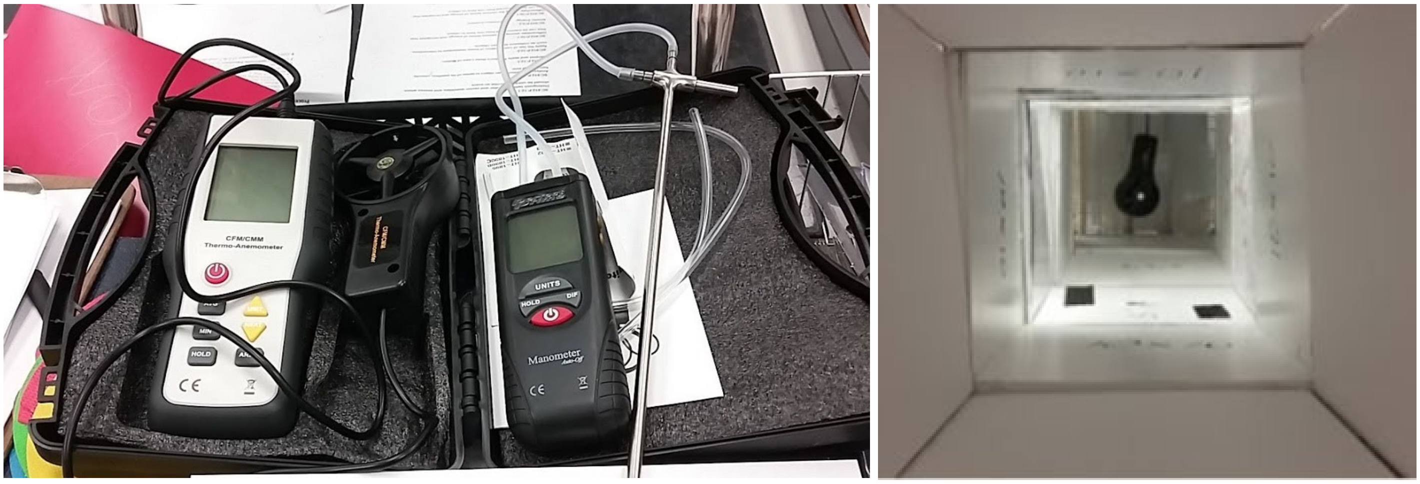
Pressure
Pressure difference
Pressure Taps
Coefficient of Pressure
Pitot Tube
Force
Fluid flow
Velocity
Bernoulli’s Equation
Continuity Equation
Conservation of Energy
Work
Venturi effect
Venturi tube</td><td colspan="2"><u>ESE / ESOL / SPED:</u>
Log Journal
Word Wall /under TV
sharing VAKT
Report Writing
Concept Building
Small Groups</td></tr>
</table>

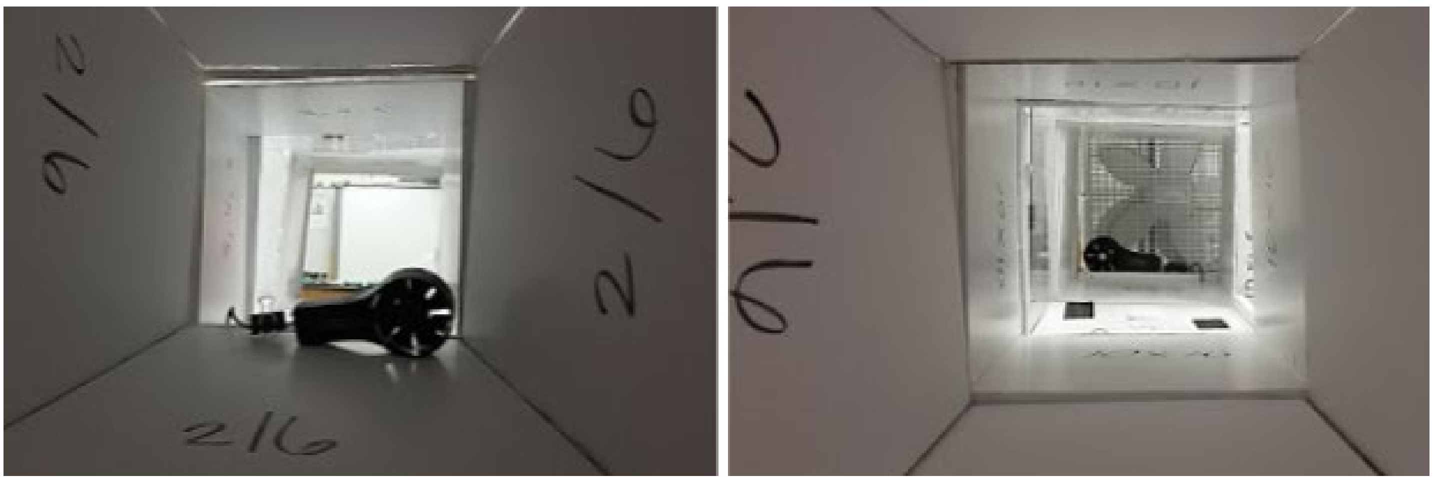
PICTURES



My Portable Wind Tunnel in my class room.

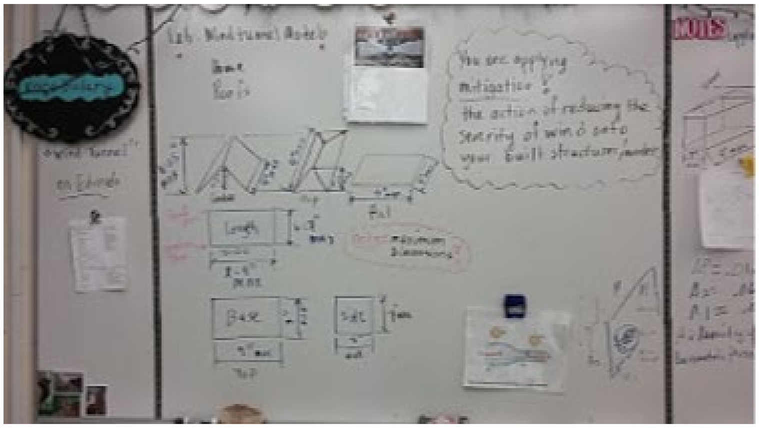


Anemometer and Manometer with Pitot Tube



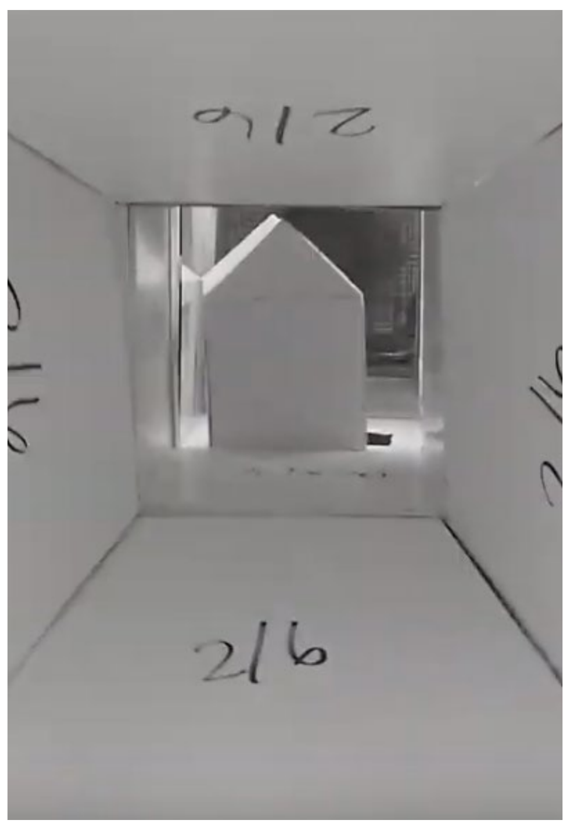
Anemometer’s fan inside the wind tunnel at various positions, tested by students

Student - Built House structures



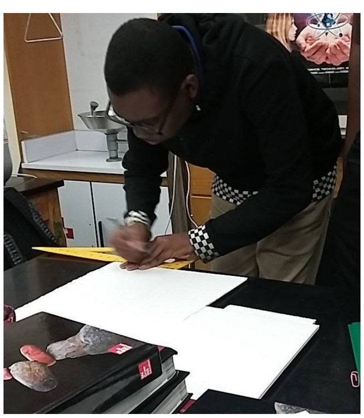
Vision Boards – style instructions

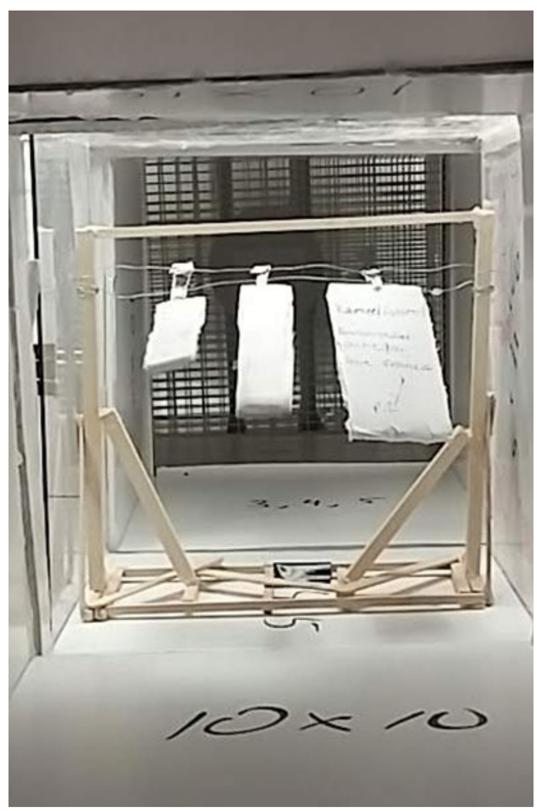
Student built House Model inside the testing chamber of the wind tunnel

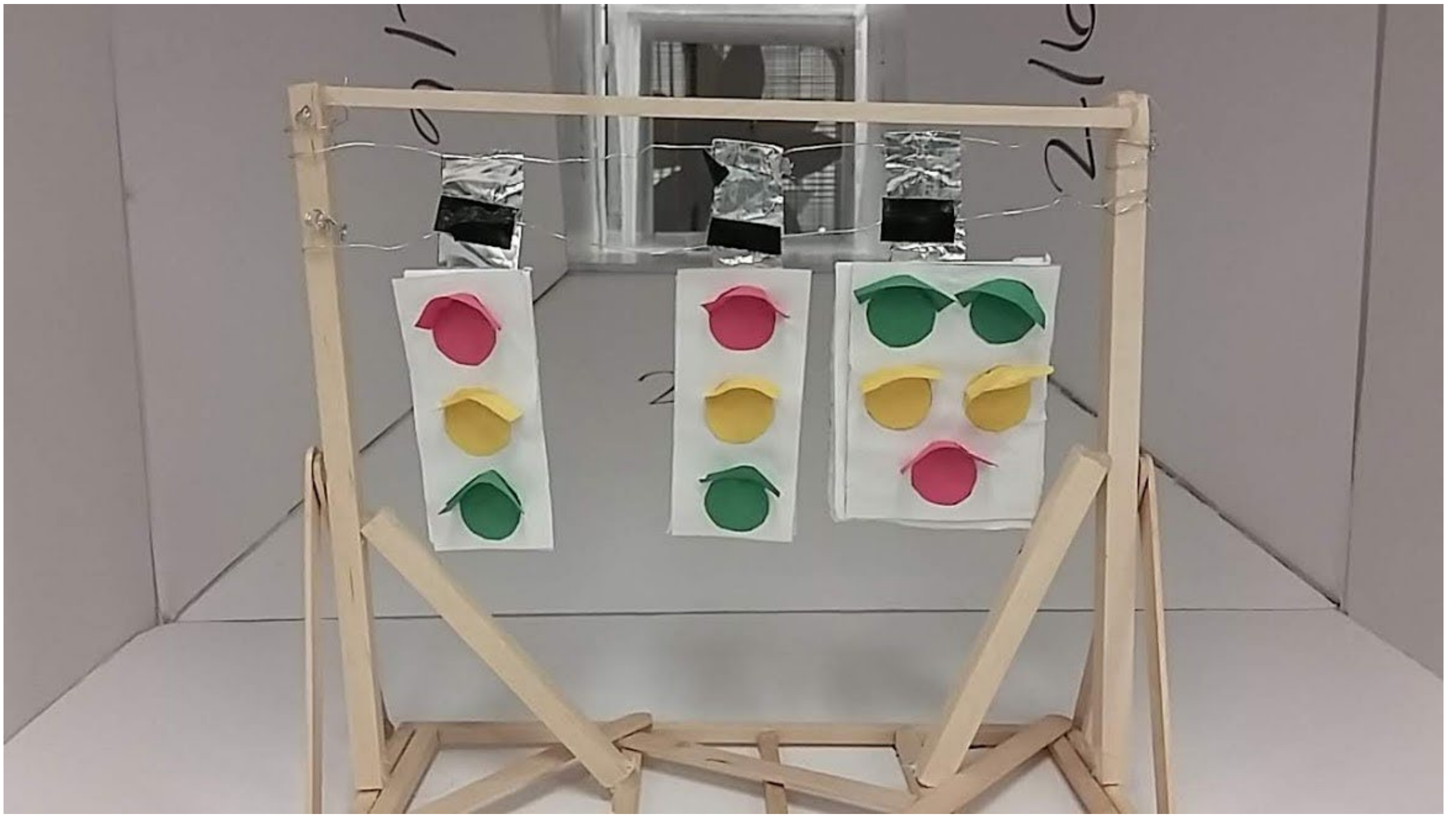


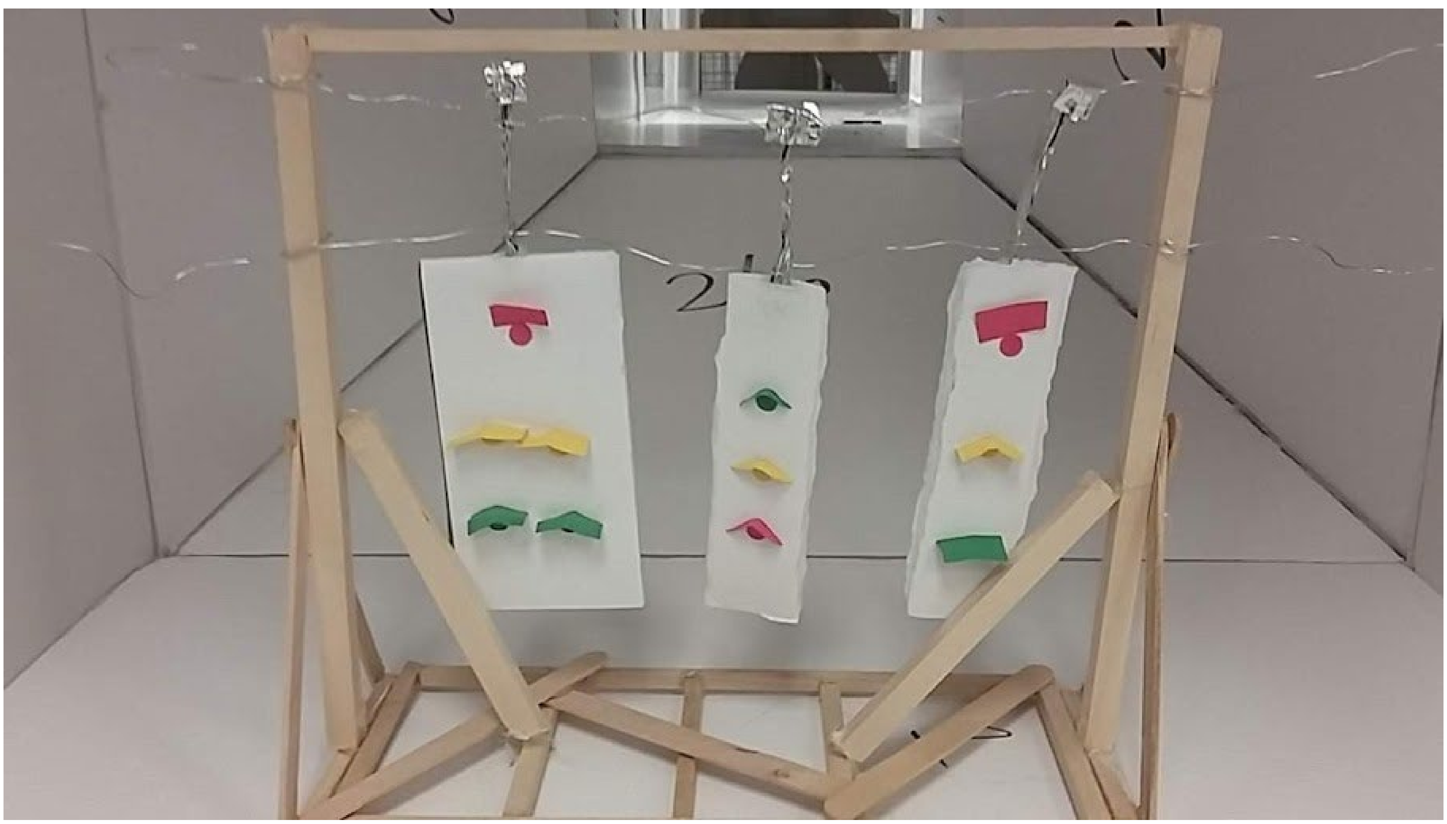
Students designed, drew, cut, built, and tested their structures inside the test chamber of the wind tunnel.

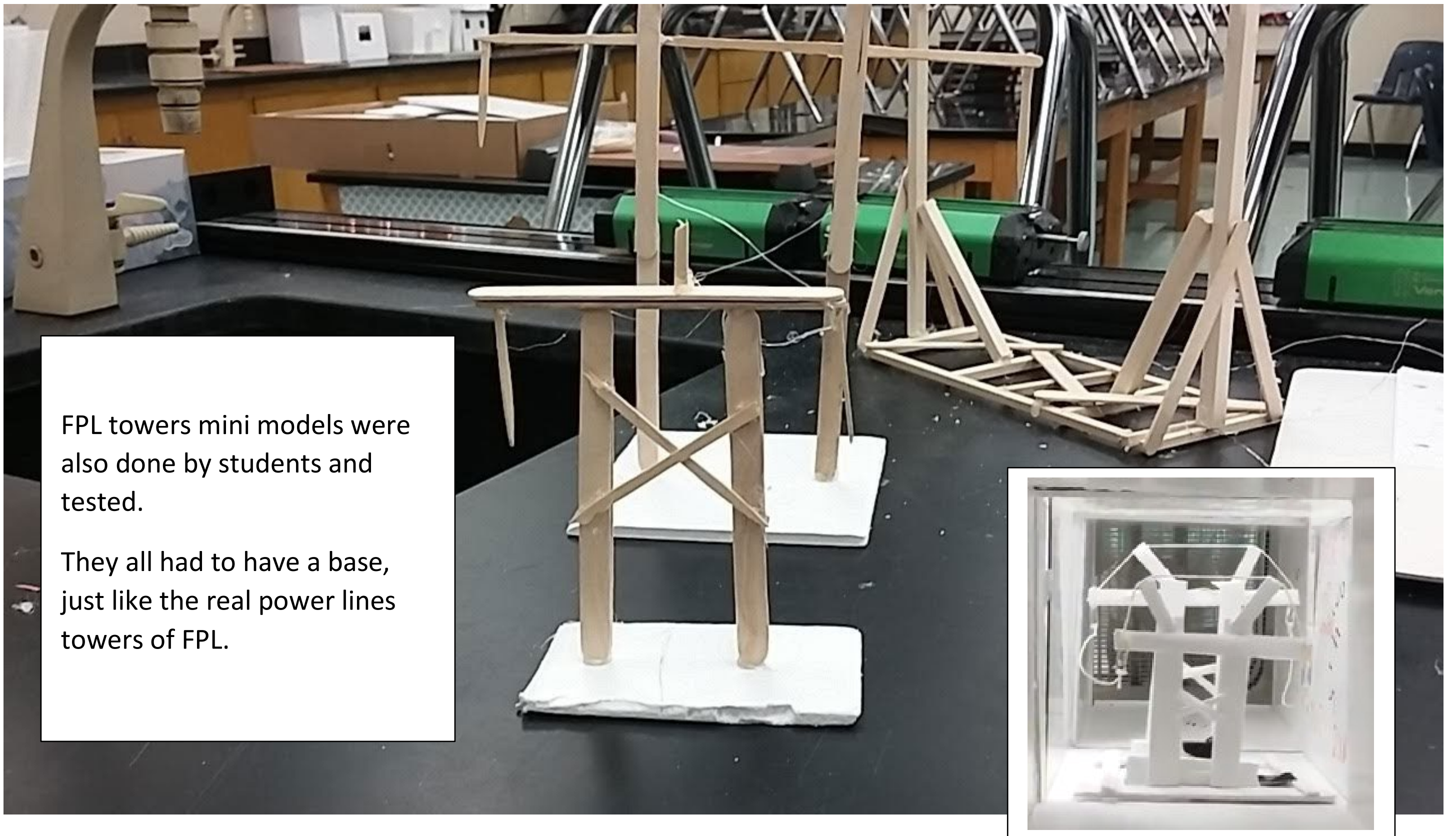
Almost all the structures withstood the winds of 3 fans back-to-back (taped to the wind tunnel because of the vibrations





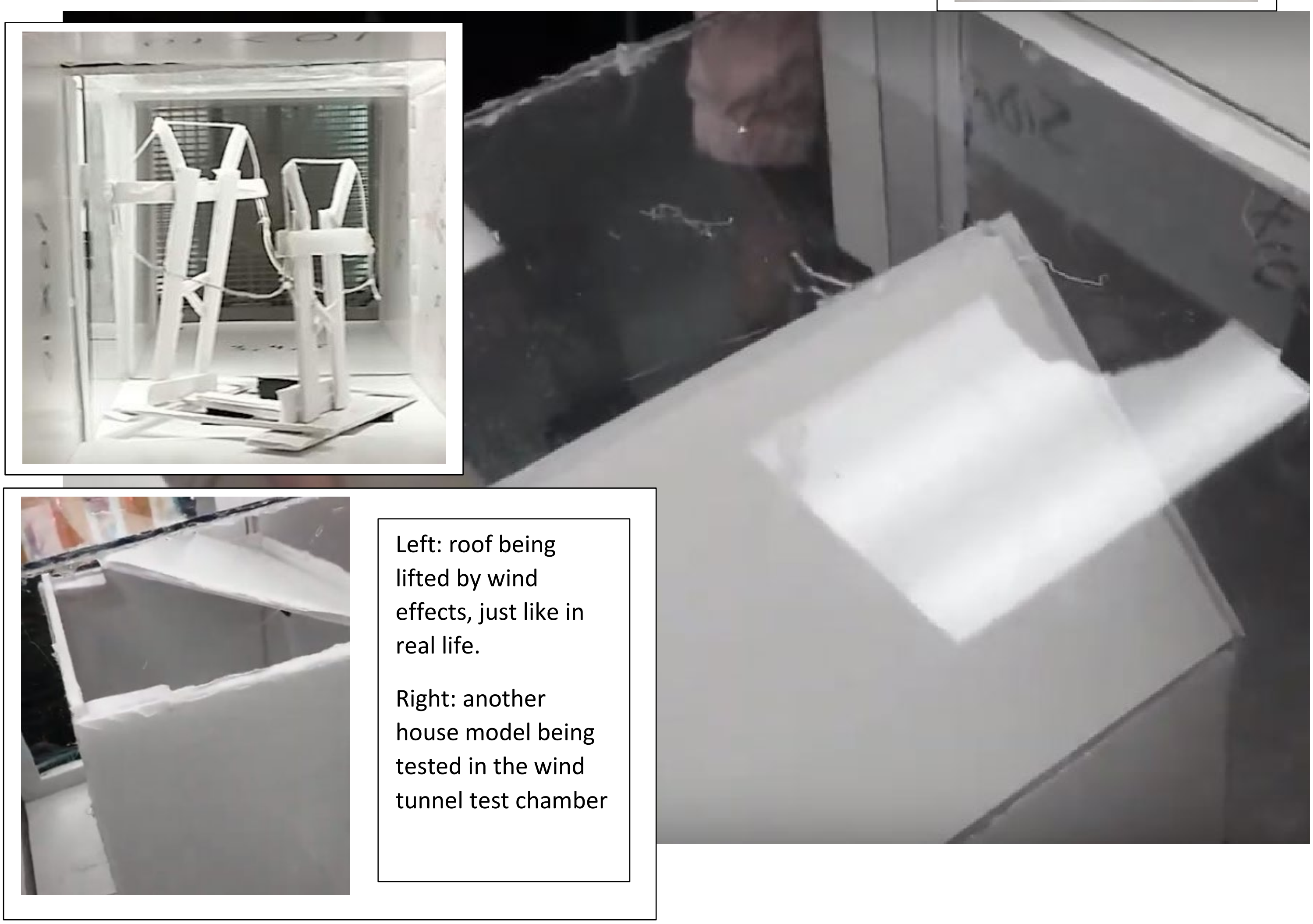






FPL towers mini models were also done by students and tested.

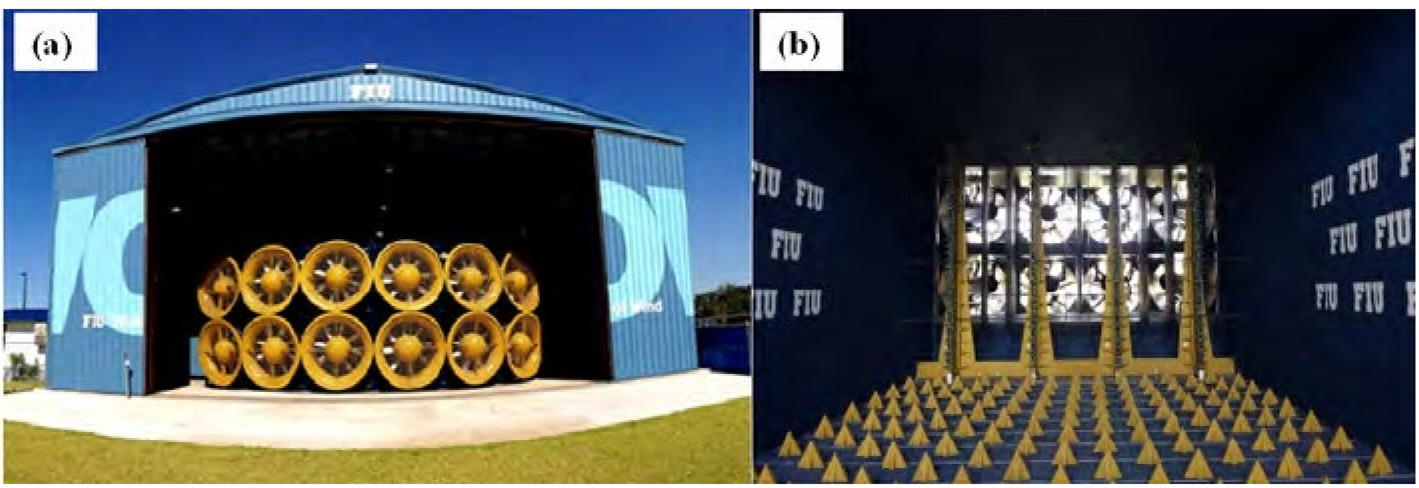
They all had to have a base, just like the real power lines towers of FPL.



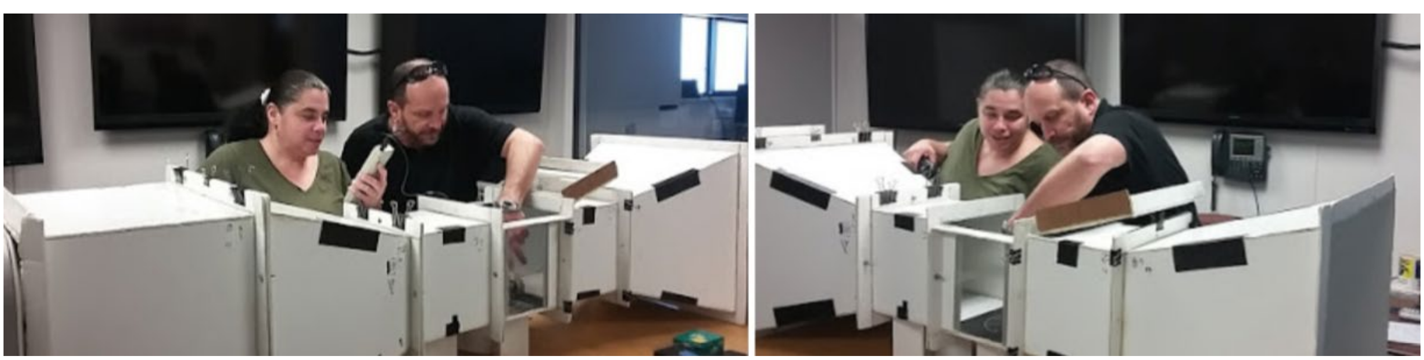
Left: roof being lifted by wind effects, just like in real life.

Right: another house model being tested in the wind tunnel test chamber

NSF NHERI FIU Wall of Wind (WOW) and FIU Engineers on Wheels



a) Back of WOW
b) Front, constraint section (spires and roughness)



Working with the original FIU WOW / Engineers on Wheels Portable Wind Tunnel, summer 2018 with Jorge Barroso.

Me at FIU WOW Testing Facility with Research Experience for Teachers Partner, Jorge Barroso (summer 2018)

NSF NHERI FIU Wall of Wind (WOW) Control Room

Me at FIU WOW Testing Facility, summer 2019. To get an idea on the scale of the fans, I am 5 feet, 1 inch tall. The fans are very big! The fans are at the back of the tunnel.

The FIU Engineers on Wheels goes to schools and introduces student to wind engineering by having them test their homemade, built model structures inside their original, portable wind tunnel.

Build Your Own Wind Tunnel

Basic Materials list: (Created by: Jimmy Erwin and David Garber (FIU Students)

Portable Wind Tunnel Model	Glue gun & sticks
Foam boards	exacto knife
scissors	ruler

1. Create Flow Straightener:
a. Use Gorilla tape to tape tubes together. Note: this should be the same width as your fan.
b. Make 9 rows of 9 tubes.
c. Connect the completed 9 rows together

2. Create Contraction and Diffuser segments (exactly the same dimensions and procedure
a. Cut all pieces to size (see attached drawings)
b. Connect pieces a small piece of Gorilla tape. Note: walls (slightly smaller pieces) will sit inside the edge of the bottom and top pieces (slightly larger pieces)
c. Run a line of hot glue along all of the inside edges of the section
d. Initial completed section

3. Create Working Section (Qty. 2)
a. Cut all pieces to size (see attached drawings)
b. Connect pieces a small piece of Gorilla tape. Note: walls (slightly smaller pieces) will sit inside the edge of the bottom and top pieces (slightly larger pieces)
c. Run a line of hot glue along all of the inside edges of the section

4. Create Test Section (Qty. 1 or 2)
a. Cut all pieces to size (see attached drawings)
b. Cut a piece of Gorilla tape at about 8” and lay it flat (sticky side up)
c. Place strip down on tape and line up glass to be flush with the foamboard strip

d. Repeat for other side
e. Seal other side with a strip of hot glue
f. Repeat for second glass wall
g. Connect all four sides together

5. Add monster clips
a. Cut all pieces to size (see attached drawings), 1.5” strips were used in the demonstration model
b. Attach monster clips to outside by placing a strip of hot glue onto the strip and attaching it to the section. Then run another strip of hot glue down the inside.
c. Finish attaching ribs on all sides of all sections.

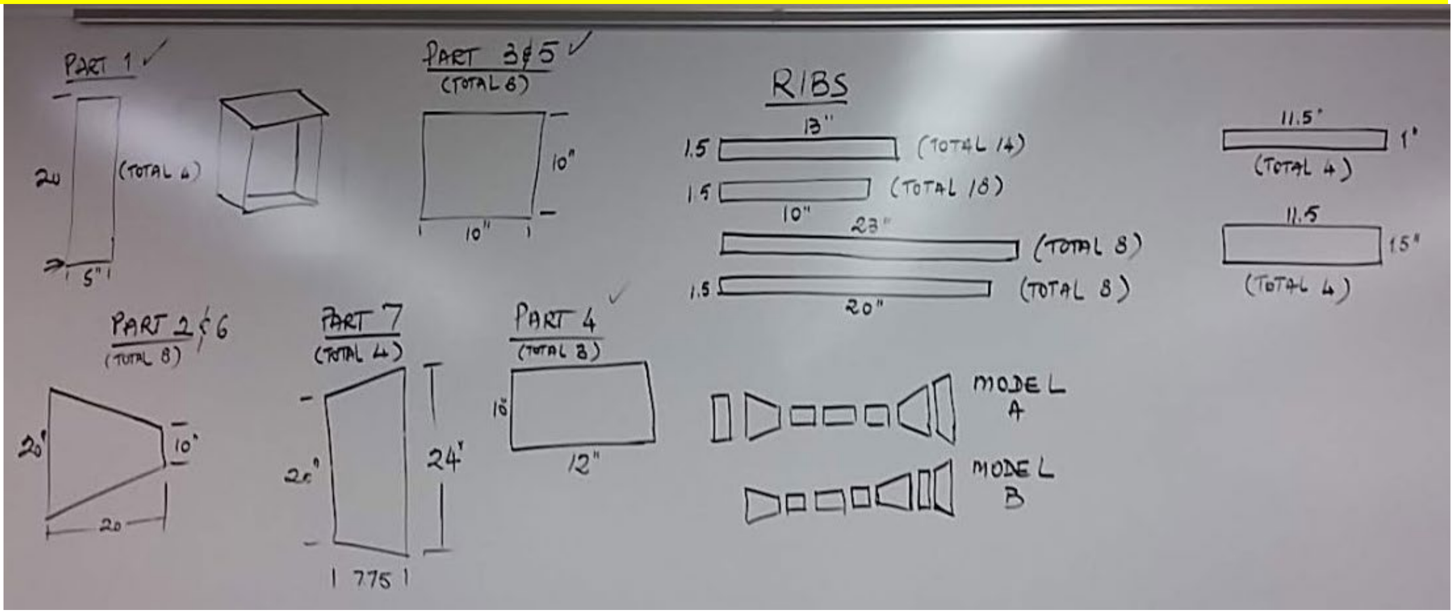
6. Create enclosure for Flow Straightener
a. Cut all pieces to size (see attached drawings)
b. Use hot glue to attach all four wall pieces together
c. Slide flow straightener into the enclosure; add hot glue as needed to secure
d. Place Contractor on Flow Straightener and make a mark around the bottom
e. Glue ribs around the flow straightener on this mark
f. Finish adding monster clips on the bottom

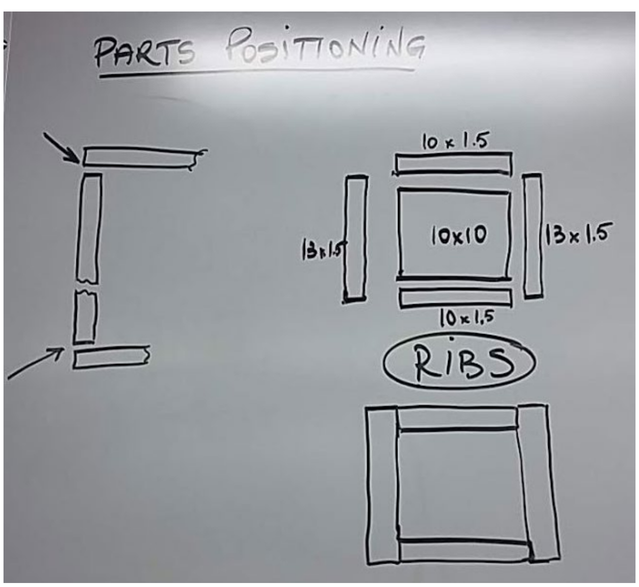
7. Drill or punch holes for connector ribs to help with connection between segments
a. Measure the location of holes on all four sides (on one side of connection)
b. Drill or punch holes in all four locations
c. Place adjacent pieces against each other (lining up the inside of the tunnel) and mark the location of the holes of the adjacent connector piece or monster clips.
d. Drill or punch these holes or just place monster clips.
e. Repeat for all segment connections

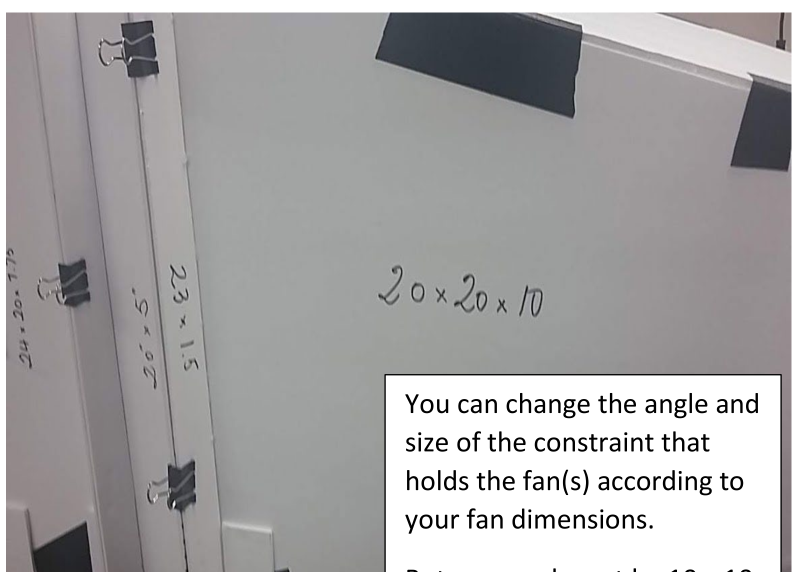
8. Connect all adjacent segments with bolts or just place monster clips.
9. Finished wind tunnel.

note: email me if you need HELP!!! Or just text me at 786-775-1977.
Love_physics@dadescools.net

Basic Dimensions:

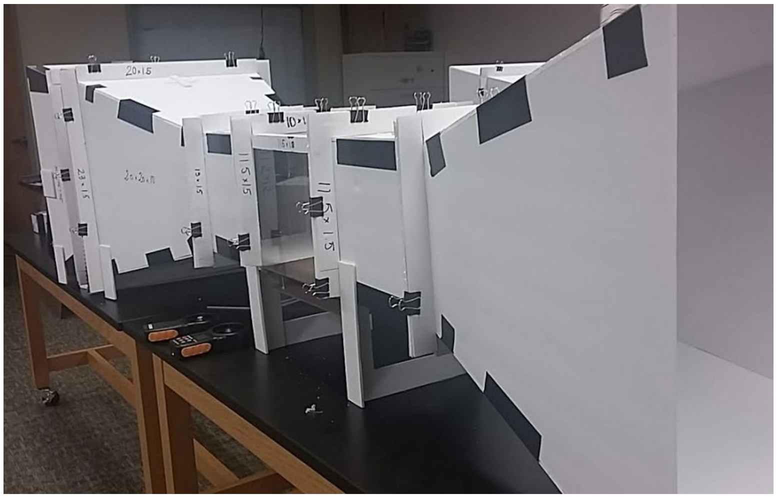






You can change the angle and size of the constraint that holds the fan(s) according to your fan dimensions.

But, one end must be 10 x 10.

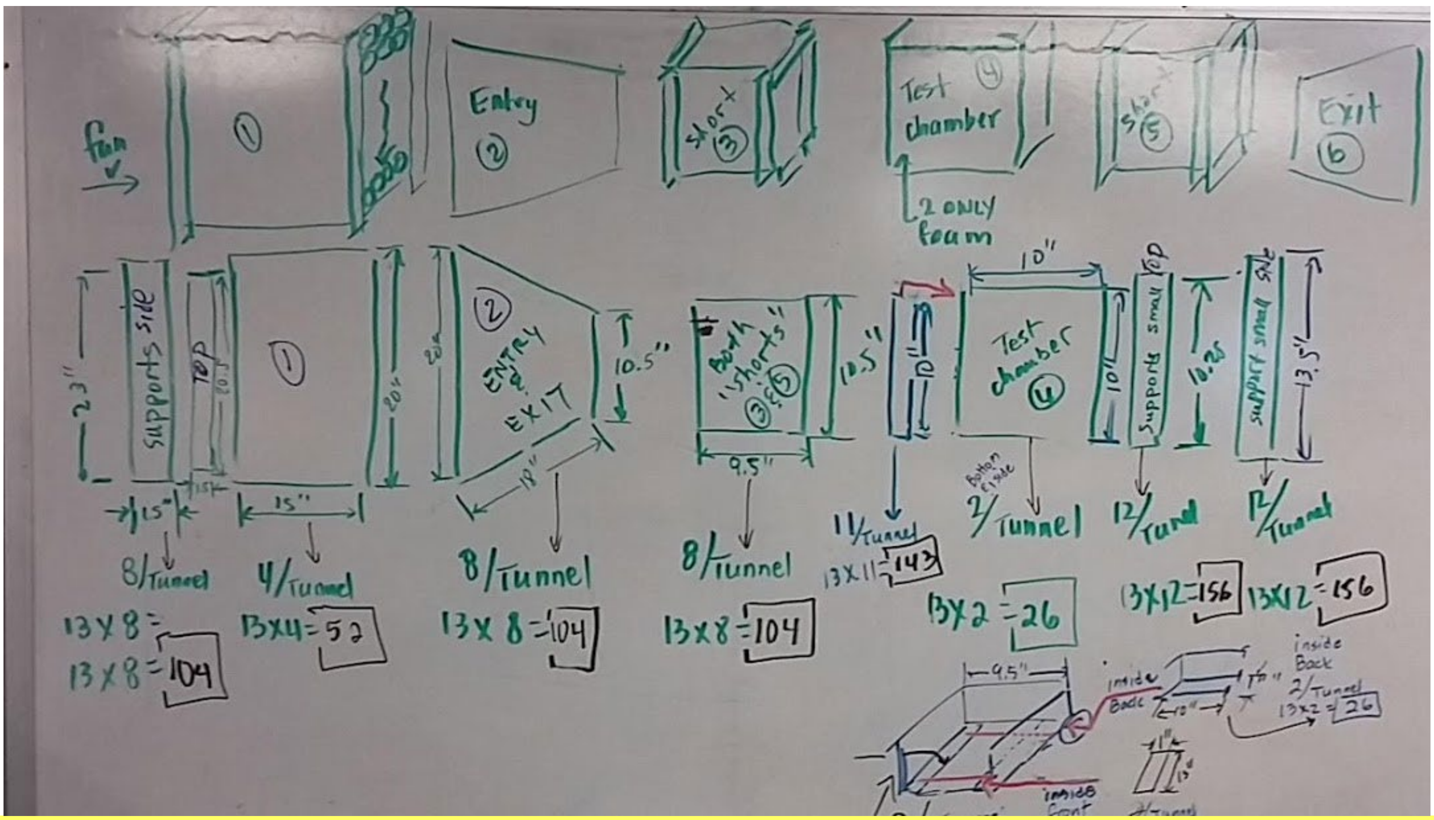


You can use Gorilla tape and / or any other that is just as good.

The green layout was drawn by me to help the West PD workshop teachers cut and then build their tunnels at their perspective schools.

Each set of 6 main parts is with a number circled. I called the ribs "supports".

The test chamber section can be made entirely out of plastic from Home Depot.



Note: ignore the black box number! It dues NOT apply to your tunnel

Possibilities / Modifications

1. Different Materials: The wind tunnel can be made from any alternate materials (metal sheet, plywood, plastics, etc.).
2. Different Scales: Larger wind tunnels can be made with larger budgets. Simply scale up all the given dimensions.
3. Smaller scale wind tunnels are also possible and can be stream lined to use with smaller fans.

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DO NOT HESITATE TO CONTACT ME IF YOU HAVE ANY PROBLEMS!

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FIU School of Engineering

FIU School of Engineering - Engineers on Wheels

NHERI – NSF FIU Wall of Wind Testing Facility

Original Wind Tunnel Model Created by: Jimmy Erwin and David Garber (FIU Students)