Tech Interactive 2023 Protection from High Winds Challenge

Engineering Notebook

Mechatronics Engineering

Storm Team #1

2022-2023 Storm Team 1 Members:

- Loc Pham, Tyler Huynh, Brian Nguyen, Landon Phan, Nam Nguyen, Peter Vu

Important Project Dates & Links:

- Tech Interactive 2023 Challenge Home Page
- This year's showcase will be in-person! Final Showcase will take place (High School Showcase is **April 30, 2023**) **April 29, and April 30, 2023** at South Hall, 435 S. Market Street in Downtown San Jose.
- 2022-2023 Survive The Storm - Rules
- What needs to be in your Engineering Notebook - Guide

10/25/2022 Tech Interactive 2023 - Protection from High Winds - Challenge

Introduction to the 2023 Tech Interactive Challenge.

Planned Task List:

- ☑ ~~BrainStorm what this challenge needs, what resources we will need and what topics we will need to research~~

Useful Reference Links:

- Tech Interactive 2023 Challenge Home Page

What Will We Work On Next Time?

- ☐ Create Teams and allocate project work.

Class Notes: <enter class lecture notes, Team notes, Discussions and Brainstorming topics here>

What Did We Working On Today:
BrainStorm What is needed to build a cool Wind Tunnel Results:

Name	Idea/Topic/Resources/Materials/Technology - PM	Notes
Mr Burnham	Find and Build a wind tunnel. Find Instructions / Instructables	

Mia Trinh	- Structure that evenly distributes wind
	  - Spiral structures could potentially increase wind resistance
	  - No rigid structures
	- Provide smaller structures around the primary building to reduce impact
	- Avoid overhangs b/c increased wind pressure could lift rooftop off buildings
	- Foundation (steel rods)
		https://www.aggressivehydraulics.com/how-to-use-hydraulic-cylinders-in-construction/

Duy Bui	Learn about building structure: how it distributes weight, etc. Maybe flexible materials. We can learn about aerodynamics, what happens when the wind hits the building, how to measure force.	Wind simulation
Kevin Han	Wind tunnel simulator to test 3d models of wind blocks Turbine speed = speed of the wind? http://microcfd.com/3d.htm	

Jade Jacobs	- How to measure the wind in the tunnel (sensors, other machinery)
	  - Wind speed can be calculated using wind speed = volumetric flow rate / flow cross section area
	  - Volumetric flow rate = how much cubic feet per minute of air the fan displaces.
	  - Flow cross section area = square footage of the testing area.
	- How wind affects different materials (what's the best material to resist/**deflect** wind and durable, maybe **flexible** in someway)
	- How to produce high speed wind that is accurate to the wind tunnel used for testing in a safe manner.
	  - Being able to control the speeds of the wind using a variable voltage switch.
	- Different geometric structures that can resist wind the most or redirect it in some way (how aerodynamic different shaped structures are).
	  - Use simulations on computers to test different structures (putting a 3D model of a structure in a high speed wind stimulation to see how it does).
	-
		- Wind tunnel simulation info
		- How to make a wind tunnel instructable
		- Cardboard wind tunnel instructable
		- NASA how to build a wind tunnel

Vineet Vinod	- Aerodynamics to model the efficiency of the structure. - We could make a 3D model of the structure and analyze airflow around it using SimFlow 4.0 (open source CFD software). - The structure could have a downforce producing wing on top so that the gusty winds are pushing the structure into the ground and the structure does not topple.	Homemade Wind Tunnel
Yusif Bahlool	- Best material that resists wind – Maybe something slightly springy but still tough? - Best structure that can resist wind. Size,	DIY Wind tunnel

	shape, and hollow? -	
Alexander Garcia	We can use programs where we can test the wind resistance on 3d models and since we are testing the wind resistance of a building we could look at buildings specifically designed to withstand strong winds .	
Daniel Perez	We have to check on the measurement of wind resistance and velocity.	
Ember Tardos	Architecture in hurricane and tornado areas. Might be a helpful reference.	https://www.architectureartdesigns.com/beautiful-architectural-concepts-designed-resist-hurricane-force-winds/
Noah Jung	Measure kinetic energy/velocity/pressure	
Elizabeth Borrayo	- Looking into wind resistant structures - How to create a smooth wind tunnel -	-DIY Wind Tunnel : 6 Steps - Instructables
Dale Cherne	Aerodynamic building structures and rooftops	Notes

Name	Idea/Topic/Resources/Materials/Technology - AM	Notes
Mr Burnham	Research and find Instructions to build a small wind tunnel	
Da'Quan	Little robot that listens to simple commands	
Dylan	Aerodynamic shell, made of metal and covered in butter	Design it so that when air moves over the shell, it presses the covering more into the ground, causing more friction.
Nguyen V	Some mechanism at the end of the tunnel to "read" how much wind is being blocked by the barrier, this will allow us to tell how effective a barrier design is	Look for a fan design Have a sensor for reading RPM of the fan that will be rotated by the wind
Emily	Rounded structure; some sort of dome	
Landon	Using a sensor that responds to certain actions such as detecting the amount of force is being applied.	• Search "Wind Tunnel Sensors" • Wind tunnel instruments
Ash	Use a printer fan from our disassembled printers	

	Large pvc pipe shell	
Evan Peres	Something similar to a wave electric generator to capture the wind energy	google “wave electricity generator”
Milana	Make lots of tiny holes around the structure to allow wind to flow past with less intensity For the wind generator: Should have various intensities and be easy to move in order to test different wind angles	
Brian Nguyen	Maybe program a fan to test different levels of winds	arduino
Nancy	Research aerodynamics and architecture	
Princess	A type mechanism that can ensure that the wind can flow smoothly	
Hayden Melius	3d print different types of hinges or gears that could help with different types of generators like wind generators etc.	
Arlette Lopez	Build something with a strong base, create a circular structure to smooth out strong winds.	Research how wind resistant building are made for insparation
Thaison Nguyen	For generating wind, a fan of any sort can be used, preferably a fairly strong fan(maybe can add multiple motors). For the tunnel, a cylinder shape made of something sturdy(maybe 3d printed).	
Aiden Valadez	Wind tunnels, how they work, what are the mechanics for it.	
Joshua V	Research on how to make a dome	
Nam	Research aerodynamics to control wind flow	
Kenny G	Hydraulic pistons to lift and lower a structure above/below ground.	
Andy	Research how to use an anemometer to measure the wind speeds	
Loc	Something to allow wind to smoothly flow through like a wing	
Evan Peres	research how to model aerodynamic forces in CAD	
Kenny G	Aerodynamic bunker dome that is a few feet underground.	
Evan Peres	Research laminar flow and how to move it	
Emily	Research different materials that can resist the force of the wind	
Princess	Research on what materials we would even need to create a wind tunnel.	
Joshua V	Research on how to use the air flow to our advantage.	
Luis Garcia	Research on how to use a PIV (Particle Image Velocimetry) sensor	https://youtu.be/yA9FdqJdiKk 2:00 minute mark

10/30/2022 <Notes and Information From Advisor Introduction Session>

These are some notes, links and pictures from an introduction session at the Tech Interactive on 10/29/2022.

Planned Task List:

- ☐ Find out what the challenge is all about

Useful Reference Links:

- Tech Interactive 2023 Challenge Home Page

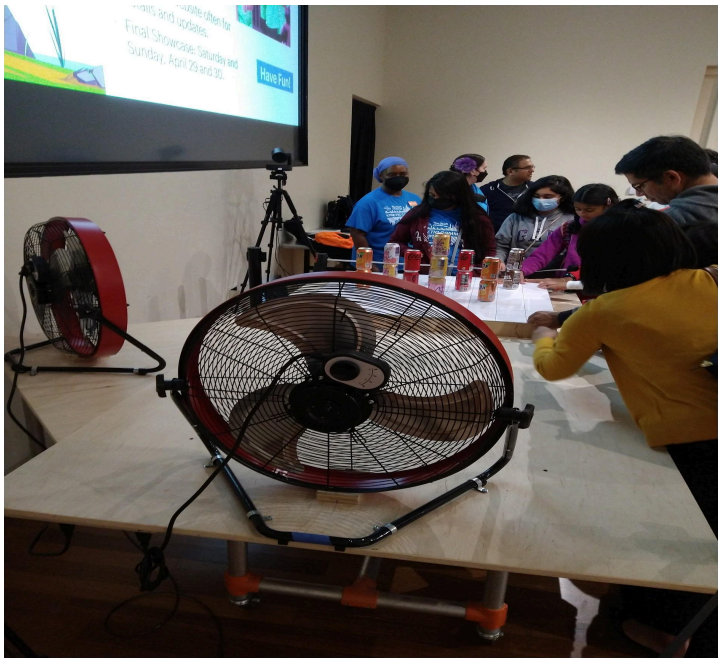
What Will We Work On Next Time?

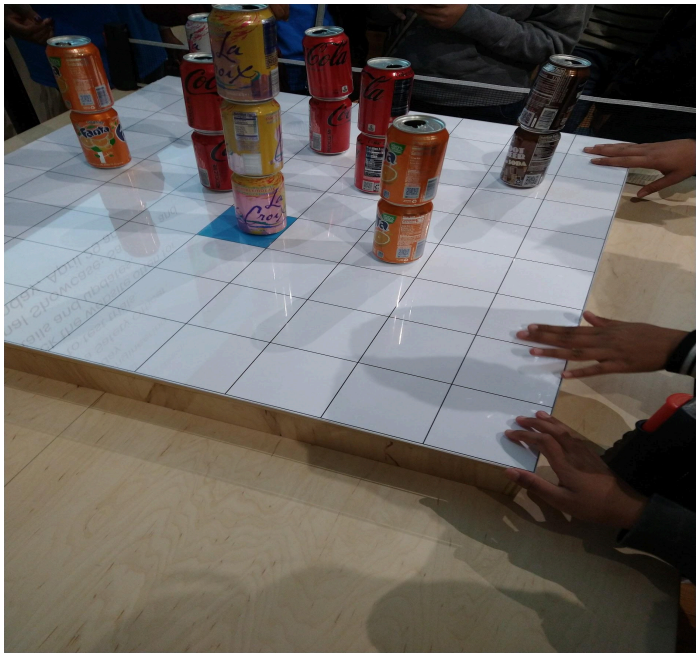
- ☐ Create Teams, and Start Planning
- ☐ What are the questions we need to answer?
- ☐ What is the exact manufacture of the Fans? Can we get some?
- ☐ What are the exact dimensions of the field? Can we build a platform? What do we need?

Class Notes: <enter class lecture notes, Team notes, Discussions and Brainstorming topics here>

What Did We Working On Today:

- <Mr. Burnham> I attended the Introduction Workshop at the Tech Interactive on Oct 29. They provided a lot of information. Links and let us see the challenge setup. See the pictures below.
- <Mr. Burnham> Links
  - Tech Interactive 2023 Challenge Home Page
- <Mr. Burnham> Pictures of the challenge field:


Have Fun!




Fanta
ROOT BEER
SODA

Day 1 - 2/10/2023 - Brainstorming

What Is The Plan Today:

We plan to decide on the general structure of our build.

Planned Task List:

- ☑ ~~Cardboard Box~~

Useful Reference Links:

-
-

What Did We Working On Today:

- We found a cardboard box to use as our starting point.
- Planned out other designs

What Worked - What Steps Did I/We Solve:

- We plan to just put the cardboard box in front of the cans, while stacking the cans behind the box in a way where it doesn't fall down.
- Problem with this is that there are going to be 2 fans pointing at the singular box. We don't want the box to slide back. To possibly prevent this we plan to put rubber bands at the bottom of the box.
- Another design we planned was the use of pinwheel fans in front of the cans. We could place these in front of the grid so that it can take on the incoming wind, and redirect it to the sides so that less wind hits the cans.

What Will We Work On Next Time?

- ☐ Test out the 2 fans
- ☐ Test with cans positioning on the grid

Day 2 - 2/17/2023 Testing

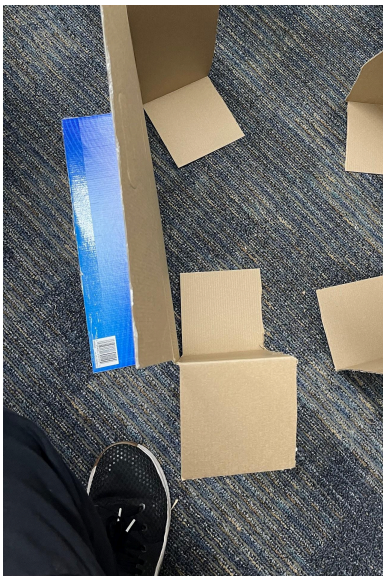
What Is The Plan Today:
Prepare the box for testing, and see results for possible improvements.

Planned Task List:

- ☐ Cut the box in half
- ☐ Test the structure
- ☐ Mark inconsistencies

What Did We Work On Today:

- We cut the cardboard box in half, so that we could cover the 2 angles from the 2 fans in the challenge. The box was also a little more than 12 ounces, so it was a way to lower it to the requirements.



- **First test-run**
- **Unofficial In-class competition (Check In)**

https://drive.google.com/file/d/11g9PD54HPPCBOWIYfW8m1ZfFedA_ouo8/view?usp=share_link

What Worked - What Steps Did I/We Solve:

- First test run our test run the box was knocked over very easily. We assume this was because of the area that it was in contact with the grid as way less than when it was an intact board. It also might be that the structure itself was now too light, as each half was a bit over 5 ounces.
- Maybe our next try we can add tape and rubber bands so that it sticks to the grid better.
- OFFICIAL TEST: We passed the test, holding the cans upright with our half box for 30 seconds. We put rubber bands onto the sides of the flaps for grip on the grid. We also put a placeholder metal tool weighing 5 ounces at the front flap for more resistance against the wind.
- We found that the only thing that can come in contact with the grid was pure cardboard, so for the next test we need to remove the rubber bands and make sure that the two flaps that come in contact with the rig are pure cardboard.

- **Challenges, Questions, or Roadblocks:**
  - [ ] Staying within weight restrictions

What Will We Work On Next Time?

- [ ] Add Pillars to Keep Flaps From Moving
- [ ] Create 3 weights to add to the front and sides of the wall
- [ ] Test foldability to make sure it fits in the backpack
- [ ] Glue regular cardboard to two side flaps

Day 3 - 3/3/2023 Modifications

What Is The Plan Today:
So far, The modifications we made are still in progress, but we added an extra wall because of the rubric. The last time we worked on our project resulted in a test. The prototype was a success, However, The rule applies that we can not use any coated cardboard, So we have to glue a layer of cardboard since our prototype whole bottom is coated. We are still figuring out what to use that can grip the wall to any surface when the wind makes contact, preventing it from falling back from the wind's force.

Planned Task List:

- [x] ~~Finish cutting the second side~~
- [x] ~~Find weights for sides~~

What Will We Work On Next Time?

- [ ] Add Pillars to Keep Flaps From Moving
- [ ] Create 3 weights to add to the front and sides of the wall
- [ ] Test foldability to make sure it fits in the backpack
- [ ] Glue regular cardboard to two side flaps
- [ ] Find a way to grip the cardboard to a surface
- [ ] Prevent two cardboard from falling from the fan with less weight

Day 4 - 3/17/2023 Support

What Is The Plan Today:
We plan on adding more support to the sides of the flaps so that it's able to stay stable when the fans are on.

Planned Task List:

- ☐ Add supports to keep the wall upright
- ☐ Adjust design to fit accordingly to rules
- ☐ Weight limit changed from 12 ounces -> 16 ounces. Plan to adjust design to accommodate extra weight

What We Worked On:

- Our current design worked well but the problem was that we did not have enough weight to hold it down
    - This is later fixed due to the change in ruling where the amount of weight is increased from 12 ounces to 16 ounces. This allowed for greater use of weights holding down the sides of our contraption and keeping it in place.
- We first tried connecting sticks to the sides of the wall. If we put them at an angle to create a triangular shape it would hopefully keep the wall up. We had trouble taping them to the wall and they didn't have enough surface area to create a stable foundation to hold up the wall so we ended up ditching the idea.
- We then opted to cut out some triangles out of cardboard instead and use those pieces. They were much easier to tape to the board.
- After some testing the wall could stand upright but it was easily getting blown by the wind. We're planning on adding some extra weight in order to account for that.

What Will We Work On Next Time?

- ☐ Add nmWeights to our design in order to keep it more stable
- ☐ Ensure that we're not going over the 16 oz weight limit

Day 5 - 3/31/2023 Weight Issues

What Is The Plan Today:
We plan on adding more support to the sides of the flaps so that it's able to stay stable when the fans are on.

Planned Task List:

- ☐ Add weights to keep our contraption in place
- ☐ Weigh our project to determine whether it fits in guidelines or not
- ☐ Our project currently does not fit entirely inside the backpack. Will adjust accordingly
- ☐ Possibly add more holes on the side flaps to counteract the wind

What We Worked On:

- There were a lot of options when it came to what we could use to weigh down the board. We wanted something that we could easily adjust the weight of whenever we needed, so that it would be easier to make sure it fit within the weight limitations.
    - There were a few options such as sand, batteries, color pencils, etc. Sand would be easily adjustable, but could get messy and could not be spread out, since it had to be held in bags.
- After weighing our current design, which included two walls, both with two flaps each, we discovered that it weighed 20 ounces, which was 4 ounces overweight. So before we could move forward and add more weight, we had to get rid of some. Next time we plan on cutting down some of the unnecessary flaps in the design that add weight but serve no purpose. The walls currently have about 4 flaps on each, coming from each side. The side ones allow us to wrap around the cans better while the top flap gives us height to cover the high towers. The bottom flap creates a more stable foundation. So it's going to be hard to decide what to cut.

What Will We Work On Next Time?

- ☐ Look for more efficient ways to use our weights
- ☐ Possibly redesign project to increase aerodynamics
    - This would be done by creating a more triangular shape rather than square-like
    - We would also need to fit our project inside our backpack
- ☐ Cut flaps to reduce weight since we exceeded the limit by 4 ounces

Day 6 - 4/21/2023 New Member!

What Is The Plan Today:
Redesign project from scratch

Planned Task List:

- [ ] We plan to redesign our project from scratch by using what worked and what didn't from our prototype
- [ ] Need to gather materials and parts for our next build
- [ ] Work on cutting down unnecessary weight in order to prioritize more efficient use

What We Worked On:

- We recruited a new member who had his own ideas, so we decided to reevaluate our plan to come up with something that would take the best parts of both our designs and combine it into one
    - Our new member's design was to create a three part wall that had a triangle center and two adjustable walls taped to each side. Since our design involved two walls already, we thought why not use our walls as the side walls and tape it to the center triangle that was part of his design.
- In order to do this, we had to cut some parts of our walls. Since this new design was sufficiently supported, we no longer needed the small triangle supports that we created on Day 4. The side flaps of our design were also no longer needed since the walls would be attached to the triangle, so we took them off. We also cut down half of the top flap so that it matched the height of the triangle. This height was measured and would cover all the cans.
- This new design really cut down on our weight, so we had a lot of room to add more weight where it was needed. The holes we previously cut into our wall combined with the ones in the triangle would help reduce weight while letting a stable level of air through.

What Will We Work On Next Time?

- [ ] Tape all the parts together, test, and add any needed weight
- [ ] Do some final tests to see if the design works effectively
- [ ] More efficient weight use is needed as our contraption still moves slightly at the highest speed
- [ ] We still need to figure out how to fit our project inside our backpack since the corners still pop out slightly
- [ ] Get ready for the competition by reviewing guidelines and rules to see whether or not our project fits in.

Total Weight of New Design

Day 7 - 4/25/2023 Trial Runs

What Is The Plan Today:
Put our new design together, test it, make any necessary modifications, and add weight in the appropriate spots.

Planned Task List:

- ☐ Tape the pieces together
- ☐ Test the Design
- ☐ Add Weights

What We Worked On:

- After putting the design together and testing it, it held up against the wind pretty well until the second fan hit. This is likely due to the triangular shape pointing towards the middle. Our plan to fix this is to just experiment with different types of weights and eventually figure out the most efficient placement for each of them. We decided focusing on the center of gravity works the best since that is where the wind is hitting the most
- We decided to use an extra piece of cardboard that would bend on top of the triangle so that the structure was tall enough to protect the towers that were three cans tall.
- We used some old batteries as weights and tested out placing them in different spots on the bottom flaps to see what placement was most efficient

What Will We Work On Next Time?

- [ ] Finalize Weight Distribution
- [ ] Improve Design to be able to withstand both fans

Testing the New Design

Day 8 - 4/26/2023 Final Additions

What Is The Plan Today:
Make some final modifications to the design to help it withstand the power of both fans. Then we need to finalize our weight distribution and fit the entire design into our backpacks.

Planned Task List:

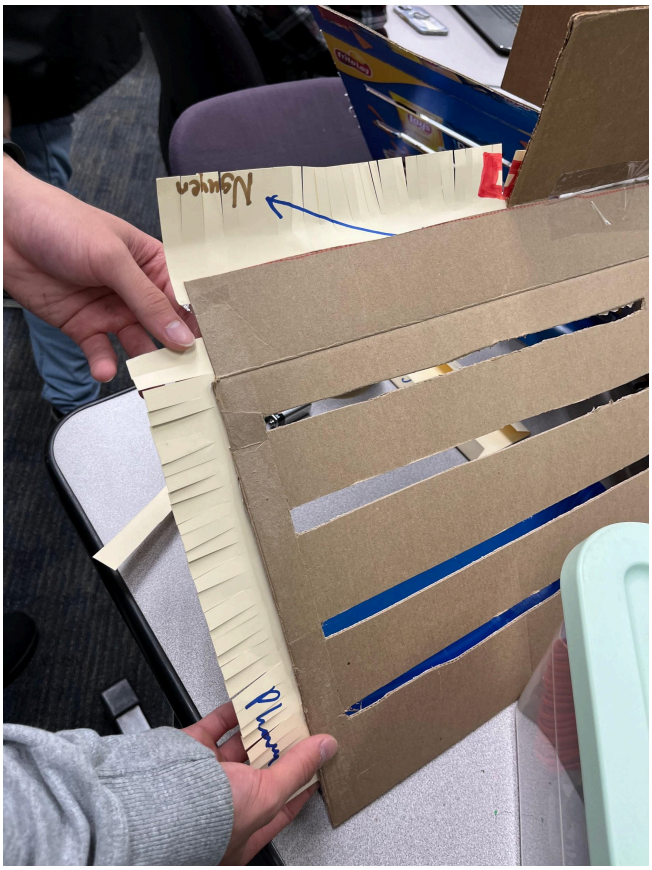
- ☐ Assess what we can add to increase resistance
- ☐ Add Weights
- ☐ Fit Design into Backpack

What We Worked On:

- Our latest modification was adding flaps made of paper onto the side and top of each wall in order to further increase the reach in our protection and at the same time not use too much weight. The flaps would also let some air through as well, reducing the overall force being pushed onto the wall.
- We also hot glued two batteries to the front triangle piece to act as weights. That area received the most force from the first fan, so we decided it was the best place to weigh down. We still have a bit of room to add a few more ounces worth of weights.
- After some more testing, we believe that we are very close to our final design. The wall stays fairly stable throughout the majority of testing but at the highest settings from both fans, it shifts back slightly and knocks over a few cans. We're hoping maximizing the weight we can potentially add to the design without going over the guidelines is our best play at improving our chances.

What Will We Work On Next Time?

- ☐ Fit Design into Backpack



The Newly Added Flaps

Weight of Current Design