The Turbines Mechanical Hand Project

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Introduction

Our goal as a group is to create a multi-faceted mechanical hand that can perform a range of motions. We have done this by building and improving on several prototypes.

The hand also needs to be able to perform several tasks in an efficient manner

- Pick up a die and turn it
- Pick up and transport a golf ball
- Stack three blocks
- Pick up a cup and empty the contents into another cup
- Make a ‘like’ or thumbs up motion

Problem Statement

We, The Turbines, as a team have been assigned the project of creating a mechanical hand that will be capable of executing a predetermined list of tasks while being limited by the specified raw materials allowed to use.

Executive Summary

- We as a group decided to start by building a basic prototype in order to see what our biggest challenges were
- We noticed that we had issues with stability in the hand, poor thumb function and grip force
- Measurements were then taken and a second improved prototype was created
- The second prototype was created and able to perform the required tasks
- The third prototype builds off of the second prototype and allows better flexibility
- The hand while being sturdier also allows the fingers to slide in between the layers
- The only downside to the third prototype is the size limits its ability
- For our final prototype we increased the size and refined the hand’s construction
- The final hand performs all intended tasks efficiently

Methodology

- Hand Anatomy and Palm design
  - Fingers made of same cardboard as palm, no palm bend
  - Fingers made of same cardboard as palm, palm bends
  - Final - finger separate in a gap in the palm, palm made of 4 cardboard pieces, palm bends, extra cardboard on space behind thumb.
- Finger Design
  - A string that is pulled through strings in the front
  - Rubber band on the front, and string on the back,
  - Final - string on the back rubber band on the front
- Thumb design
  - Same design as other fingers
  - Separate entity that does not bend
  - Final - separate entity that can bend by hooking a string

Methodology: fingers

1. Cut out 20 fingers
2. Cut 15 of those fingers on each joint
3. Cut a ¼ inch off of the smallest joint
4. Glue the three same sized joints on the back of the fingers, 2 for each joint
5. Glue on piece of the smallest joint on the front and back for the fingers
6. Glue the two smallest joints on the back of the thumb
7. Wrap the smallest joints of the fingers completely in duct tape
8. Cover each joint of the fingers with duct tape

Methodology : the palm

9. Glue to walls on the back and the front
10. Cover the palm pocket with duct tape
11. Put the fingers in the pocket and glue the front on.
12. Cut out ½ inch space right below the pocket. Leave the back piece intact
13. Glue ½ inch straw pieces on every joint of the fingers and the top two joints of the thumb
14. Glue ½ inch straws to the two halves of the palms in the front
15. Cut 5 2 ft strings, attach to the tip of the finger, pull through the straws.
16. Cut out ¼ inch straws and attach to the back of each joint.
17. Cut a rubber band in half and glue to top of fingers, going through straws, attach at the knuckles

Methodology: Thumb

18. Attach the thumb by a string with no leeway.
19. Tie a string to the last joint of the thumb.
20. Glue a straw to the bottom side of the palm right under the thumb
21. Glue a rubber band to the palm bend and attach to first joint on thumb taut
22. Glue a string to the top of the thumb and separate the threads apart
23. Pull an even amount of threads over the top and bottom of the thumb.
24. Braid strings back together then pull through the last straw.
25. Glue the string to the end of the forearm

Methodology - strings

26. Cut the ends to be the same length as the slip knot
27. Wrap duct tape around your finger sticky side out, attach strings to duct tape
28. Wrap second layer around finger, smooth side out. Repeat for all 4 fingers
29. Measure the string on the thumb joint to the correct length and tie a slipknot.
30. Wrap the slipknot with duct tape
31. Using duct tape and glue, attach a hook onto the index finger thimble
32. Measure the joints with duct tape and attach above the straws
33. Glue rubber bands onto the duct tape
34. Glue one layer of cardboard onto the top of every finger
35. Glue rubber bands on the top of each finger

Methodology: Motion Analysis and Function

- Thumb has more mobility than rest of joints, and can bend, but is prone to getting stuck bent and flipping the wrong direction. It does not hyperextend backwards.
- Finger joints can fold in three locations, but has limited grip. But the can separate apart allowing more dexterity. Will occasionally pop out of socket.
- Palm now has almost identical mobility to hand. Therener web more accurately simulated but still lacks mobility.
- Grip is much stronger than previous models, but is still relatively weak. Rubber Bands make picking up things much easier
- Due to size disparity between mechanical hand size and user’s hand size, grip strength varies.

Materials Used

Cardboard

Plastic Drinking Straws(5)

String, Rubber Bands

Box Cutter

Ruler

Scissors

Hot Glue Gun and Glue Sticks

Pencil

Tape

Three Blocks

Cup

Die

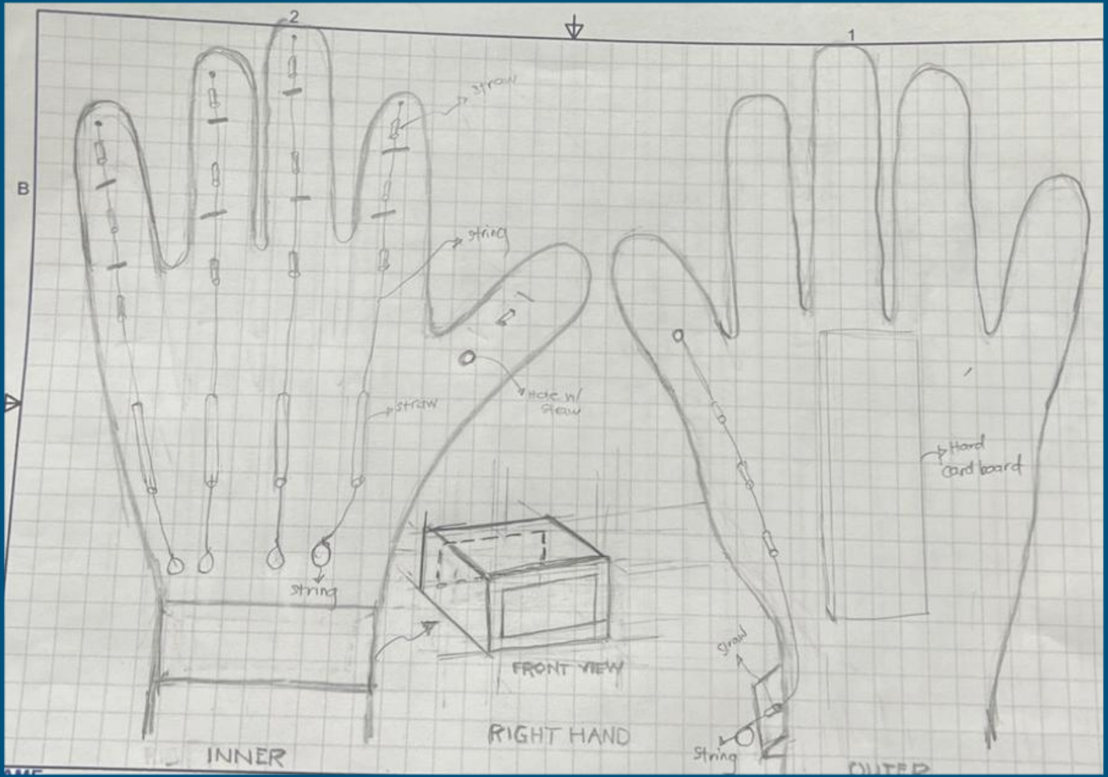
Golf Ball

Calculations and Measurements of Hand, Fingers, Thumb, Palm(Final)

Thumb, Palm, and Wrist Total Length: 2.7in +3.25in+4.5=10.45**in**
Index Finger, Palm, and Wrist Total Length: 4.5in +3.75in+4.5=**12.75in**
Middle Finger, Palm, and Wrist Total Length: 4.5in +3.75in+4.5=**12.75in**
Ring Finger, Palm, and Wrist Total Length: 4.5in +3.75in+4.5=**12.75in**
Little Finger, Palm, and Wrist Total Length: 4.5in +3.25in+4.5=**12.25in**
Angle of the Thumb: sin θ= opposite / hypotenuse (1.25in of palm)/thumb total length)
sin θ= 1.25 in /2.5in = 0.5=**30deg**

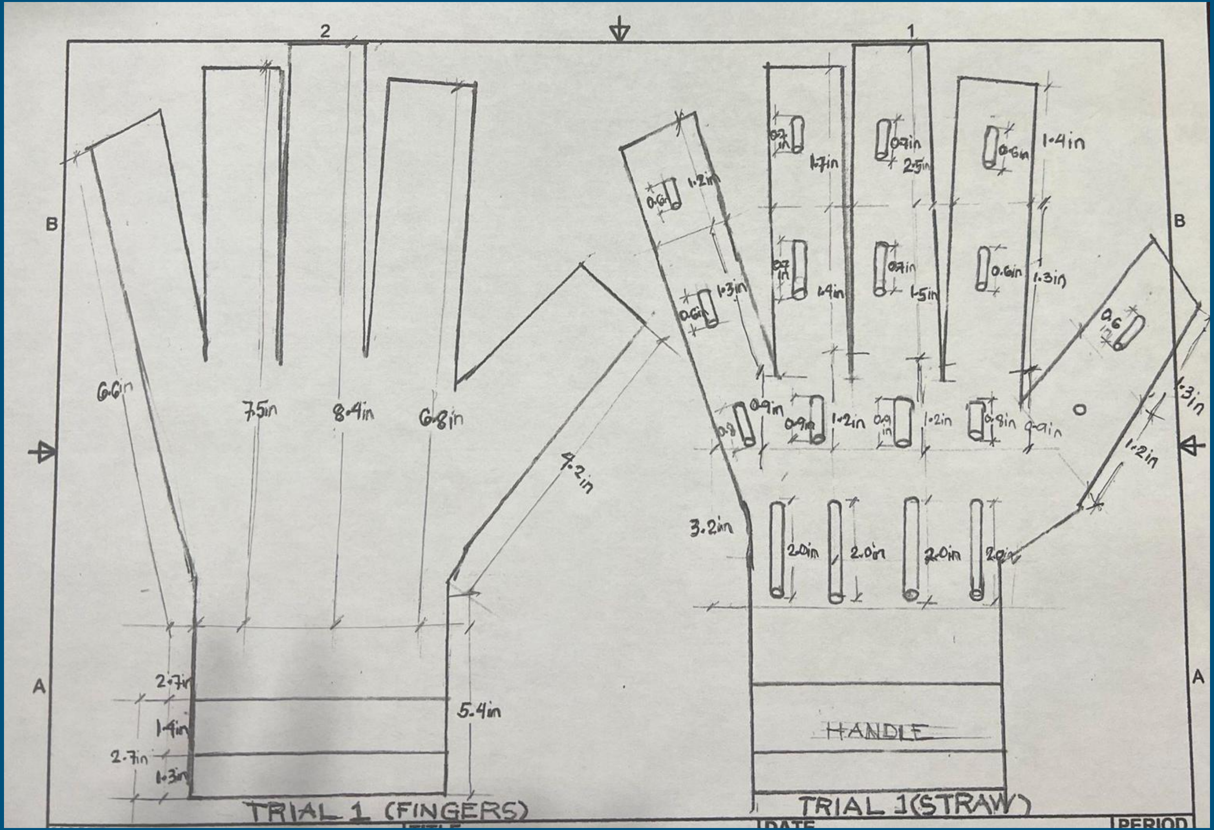
Graphs and Drawings

- Sketch Plan of the Mechanical Hand



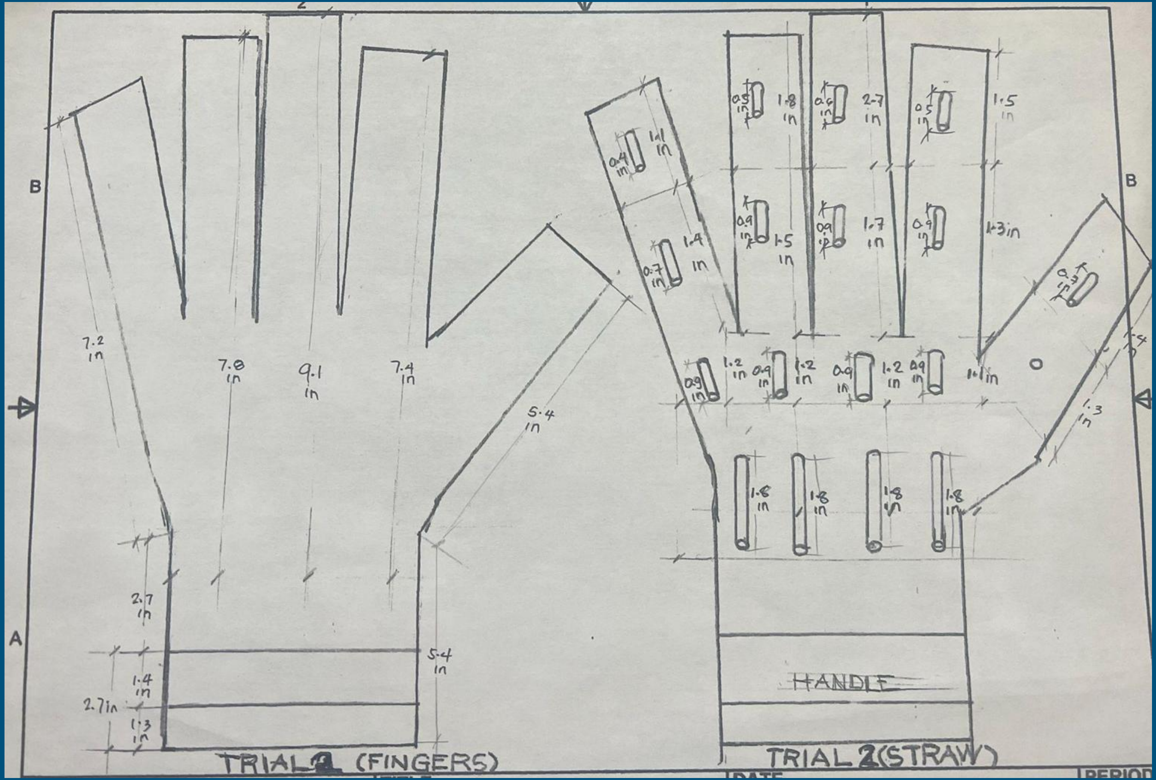
Graphs and Drawings

- Prototype 1



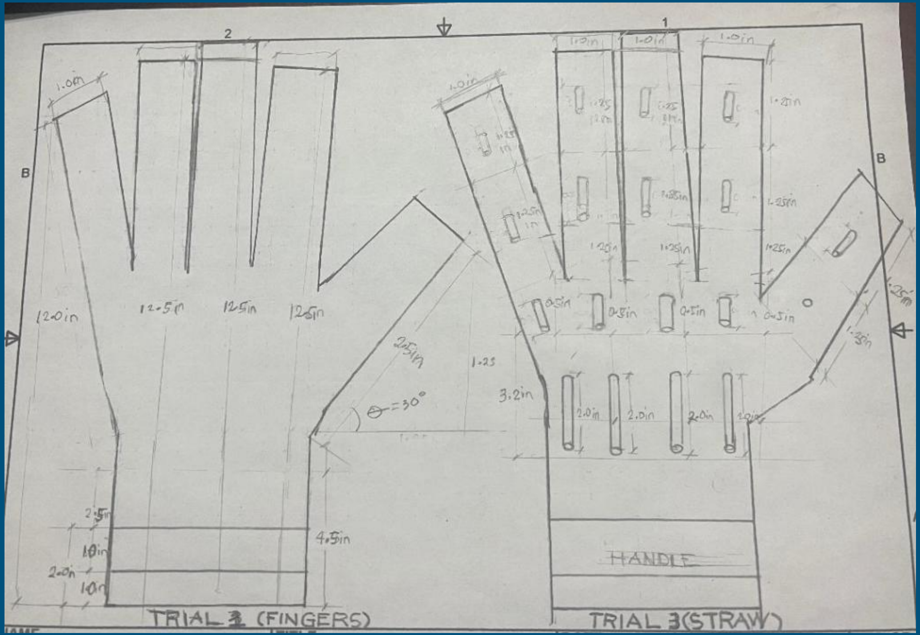
Graphs and Drawings

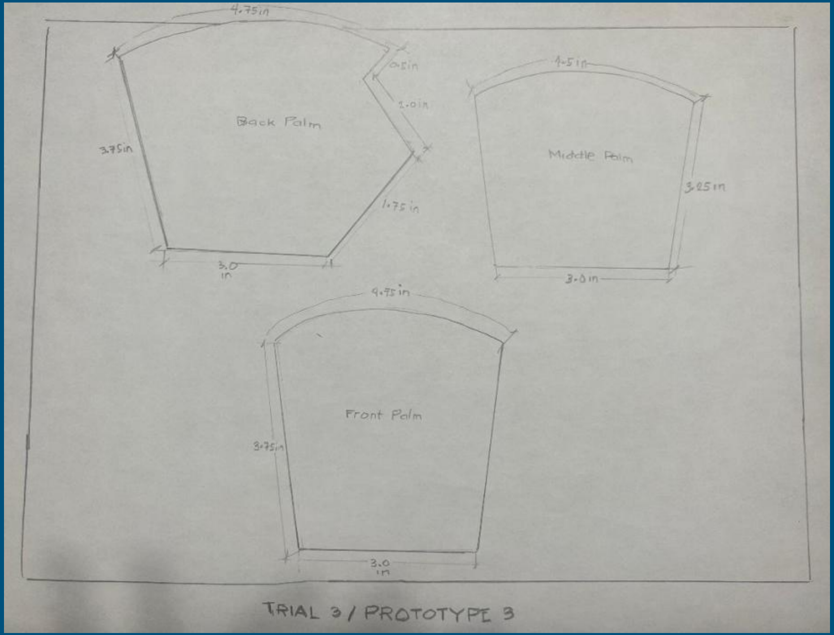
- Prototype 2



Graphs and Drawings

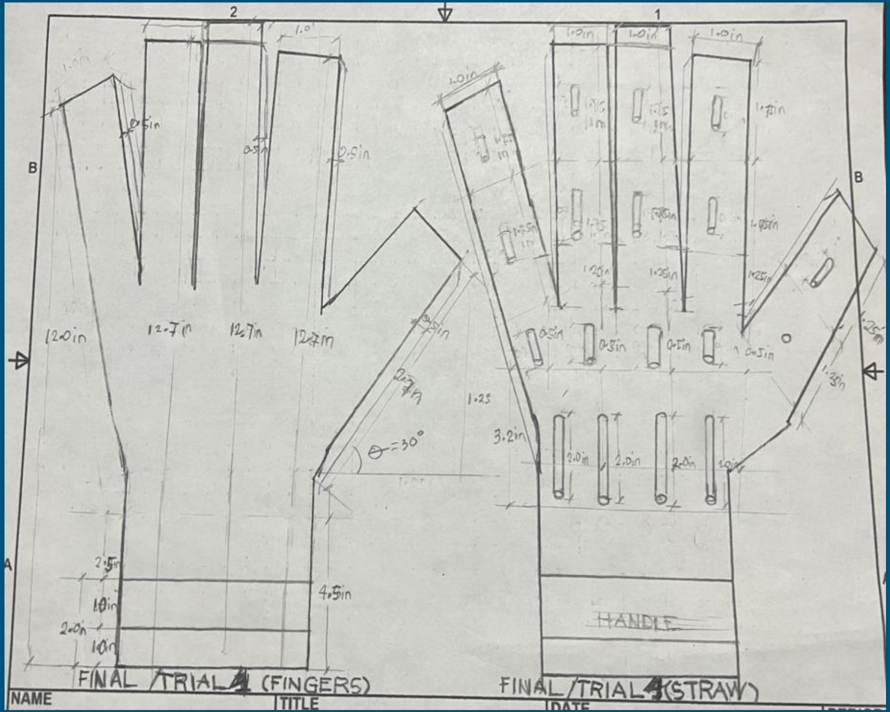
- Prototype 3

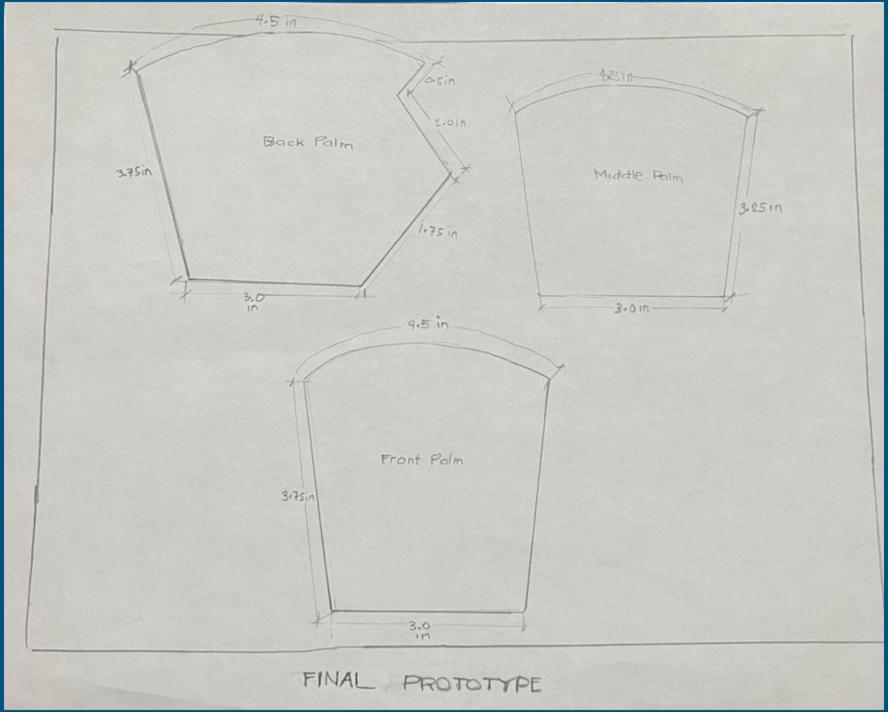




Graphs and Drawings

- Final Prototype





Graphs and Drawings

The Turbines

- Pictures of Assembling Steps

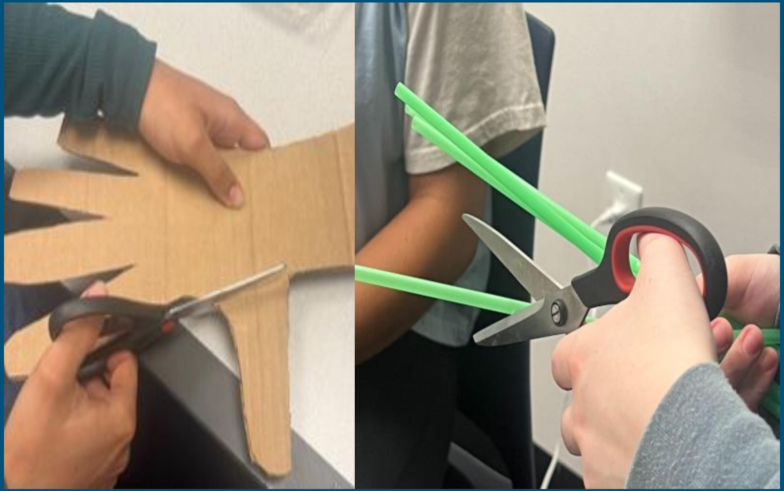
Drawing an outline of the hand using a cardboard

Graphs and Drawings

- Pictures of Assembling Steps

Cutting the outline of

the hand from the cardboard and the straw

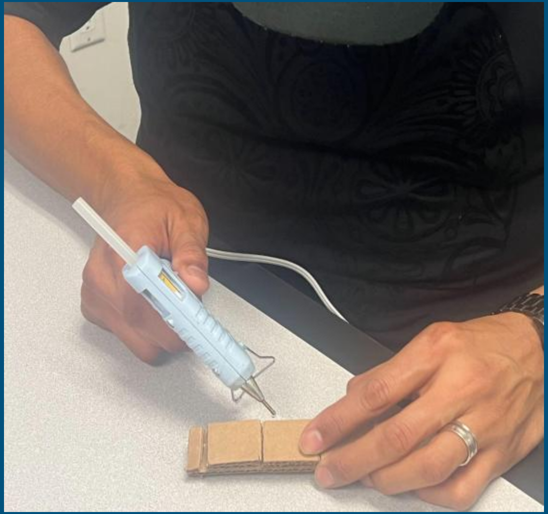


Making the Handle

Graphs and Drawings

Cutting the palms and gluing them together

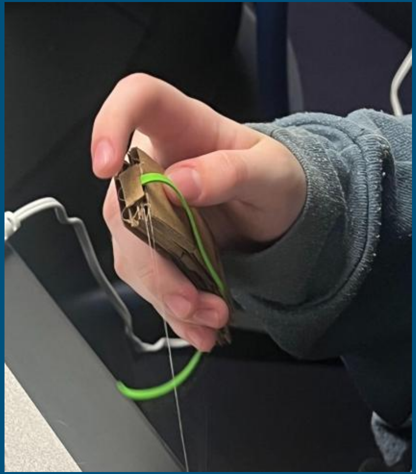
Cutting of each finger and thumb, gluing together



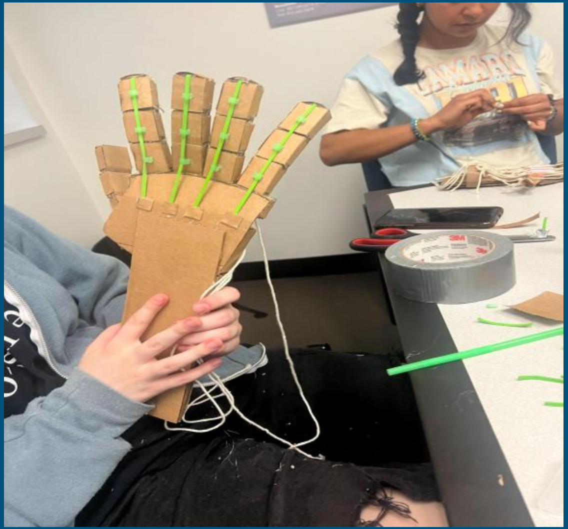
Graphs and Drawings

- Pictures of Assembling Steps

Attaching the rubber band to the back of each finger



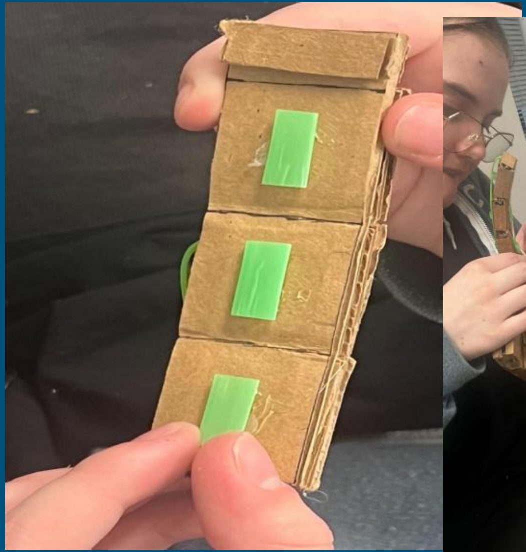
Gluing the last palm with the fingers in place

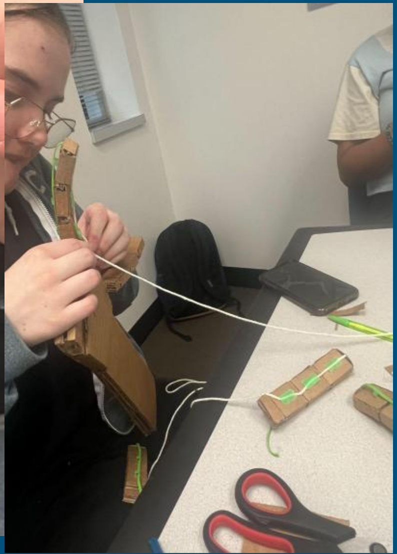


Graphs and Drawings

Cutting out the space where palm will bend and attaching the thumb sideways

Gluing of straws to each finger and palm joints, then attach string





Graphs and Drawings

FINAL PROTOTYPE

Graphs and Drawings

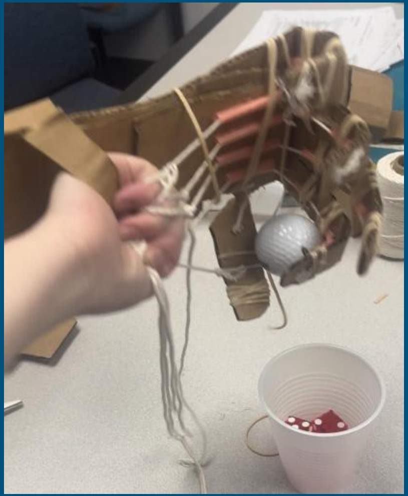
FINAL PROTOTYPE

Graphs and Drawings

PROTOTYPE 2

Graphs and Drawings

PROTOTYPE 2

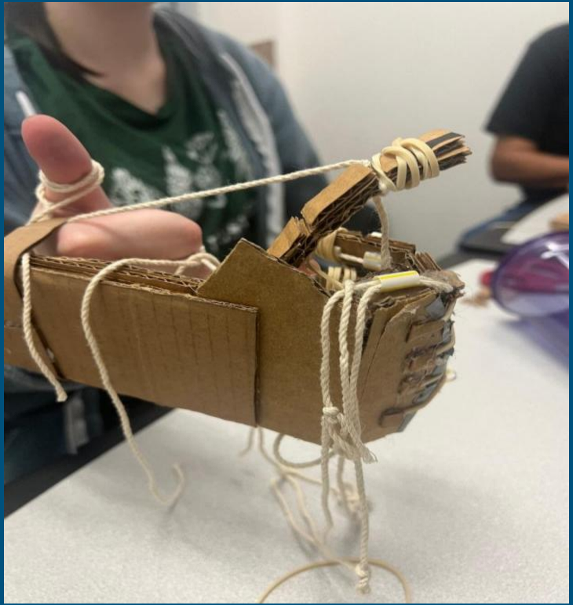


Graphs and Drawings

PROTOTYPE 3

Graphs and Drawings

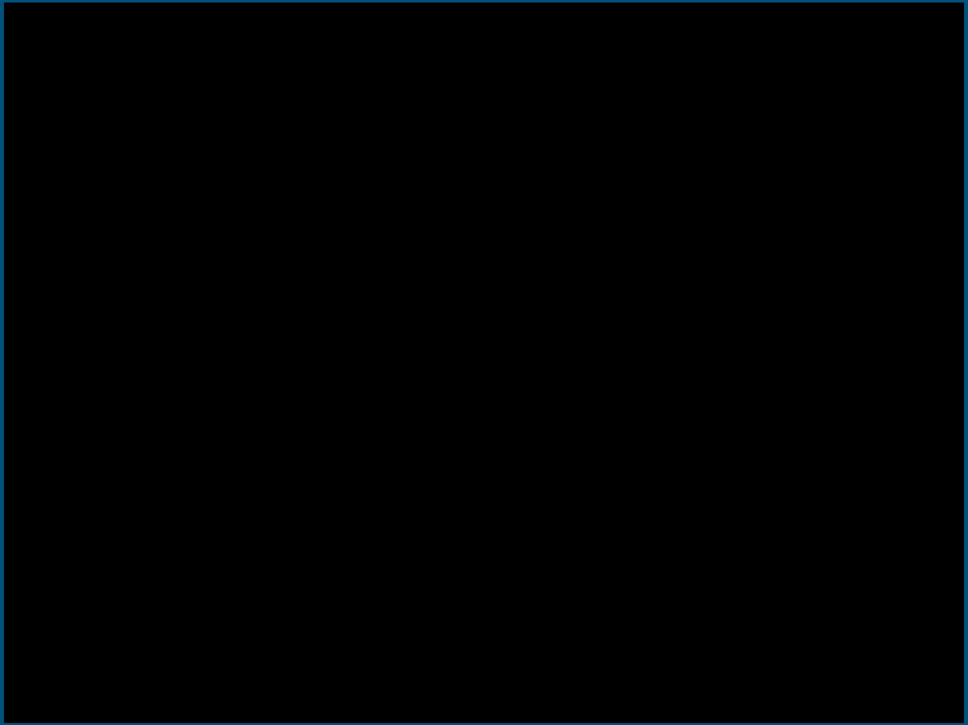
PROTOTYPE 3



Video Demonstration

Final Prototype - ABLE TO PERFORM ALL TASK

Video Demonstration
(Golf ball, Dice, Cup, Blocks, and Thumbs Up)



Discussion

- Select Hand Design
- Limited Materials
- Predetermined List of Tasks
- Thumb Function
- Finger Positioning

- Dexterity
- Stability
- Hand Grip
- Hand Positioning for Control

Conclusion

What did you learn about working in a team and the design process?

While working as a team I figured out that it is much easier to get a task done because everyone has their strengths, if one is not the best at something there will be another that is better prepared for that task. Additionally, I learned that the more the people involved the more the ideas that flow into the conversation. Even more so, I figured out that the design process can come in all shapes, sizes and measurements. There are millions of ways to create this mechanical hand and we, as a group, are searching for the best way to take on this challenge. We created four prototypes and have improved our model.

What is the achievement and outcome of your design solution?

We have been successful in completing the tasks that the professor has assigned for us, we have created the hand, stacked three blocks, held a golf ball, changed the face of a dice, and held up the like button. We have also found different ways in creating this mechanical hand and chose the best options to go about this task.

Conclusion

What improvements would you recommend for your design solution?

We needed to improve the image of our hand, so we found a way to make it neater, cleaner and more aesthetic. Additionally, we needed a more efficient way to bend the fingers for them to be able to hold items with strength and find a better gripping mechanism so that the object didn't slip and were well held. We tried a different way in creating the fingers in our fourth prototype, which solved these issues.

Did your hand have similar mobility to your own hand? Explain.

Yes, our hand is similar to that of a human hand, it is able to move around, grab object, bend, and we are able to control each finger individually. It has joints and articulations like a real hand.

Conclusion

Did your group find moving the fingers of the hand to be easy? If so, how? If not, what could you have changed in your design?

It has been difficult finding an effective way to move the fingers with ease, they were hard to bend due to the cardboard being to stiff. However, we separated and added more of the cardboard pieces for each finger, which solved the bending problem.

What is the heaviest object your hand was able to lift?

The heaviest object it has held is the golf ball.

How could you improve your model hand so that it could lift a heavier object?

Make the grip on each finger stronger by putting rubber bands all around. Even more so, finding a way to bend each finger more and make the hand structure stronger, through the use of more straw and by using separate cardboard pieces for each part of the finger.

Conclusion

How does this STEM challenge correlate with things you would find in the real world?

These type of projects are what engineers are all about, you have to find a way to create something efficiently through the use of you and a teams ideas. To be a good teammate you have to input ideas of your own and help create the final result. Additionally, in most cases you have to work with a limited amount of material. And, it is all about trial and error, you will not get the perfect result on the first try, you will have to try again and again until you resolve all conflicts and mistakes.

Why would engineers use models before they would build a working mechanical hand?

They would use models to plot the idea out and see if it worked before they created the real thing because the actual material might be too expensive to be using it like crazy, so they would recreate it, but with cheaper material. Besides, when creating the model you can keep on experimenting and adding new ideas into the project to test them out and if they work you just use it when it comes time to building the actual mechanical hand.

Recommendations

What can you do so that it can function more like a real hand?

So that the mechanical hand can function more like a real hand we could add a better gripping mechanism, the way we used the rubber bands work well enough and it looks neat, but there can always be space for improvement. Additionally, we need to find a way to be able to use the thumb more because the thumb is a very important finger in our own hand; however, it has been hard to manage on the mechanical hand. I believe we can add some more string or rubber band onto the cardboard part of the thumb to make it move where we want it to move.

What modification/upgrade do you plan to make?

We planned to make our mechanical hand more appealing and clean and have now completed that task. We installed pieces of cardboard on the sides of each finger to hide the inside work and it looks smoother. Additionally, we were looking for a way to fix the thumb problem so that we could have more control over it. We successfully fixed that problem too and are now able to use it for tasks because we attached more straws, string, and a rubber band to its connection to the palm.

Recommendations

Are there any other solutions to the problems you currently have?

There are many way to go about the problems we are dealing with, however we either haven't discovered them, they are harder to do, they need too much material, or the material isn’t part of the project rules.

What are your suggestions for your design

- Hand cut has to be a little larger than an actual hand
- Use rubber bands for gripping
- Add a three to four layers of cardboard to make the overall hand stronger, so it doesn't bend and it can be strong.
- Use a hot glue gun to stick everything, instead of tape or glue
- Use string that is thick and strong so it doesn't rip when in use
- Add a rubber band on the back of each finger so that the finger can unfold back to its original place after each use

Reference

Citation generator. Citation Machine, a Chegg service. (n.d.). Retrieved April 24, 2023, from https://www.citationmachine.net/apa

General format. General Format - Purdue OWL® - Purdue University. (n.d.). Retrieved April 24, 2023, from https://owl.purdue.edu/owl/research_and_citation/apa_style/apa_formatting_and_style_guide/general_format.html

YouTube. (2017, March 24). *How to make a robotic arm at home out of cardboard*. YouTube. Retrieved April 1, 2023, from https://www.youtube.com/watch?v=c9FuPdl3xCE

YouTube. (2018, October 29). *School Science Projects Robotic arm*. YouTube. Retrieved April 1, 2023, from https://www.youtube.com/watch?v=2xgmlQiShxI

YouTube. (2020, October 16). *How to make a mechanical arm at home out of Cardboard (DIY)*. YouTube. Retrieved April 1, 2023, from https://www.youtube.com/watch?v=GTH_Tzg1DmA

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