"Arms Race"

Prosthetic Arm

Engineering Challenge

FINAL REPORT

By

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Discovery School

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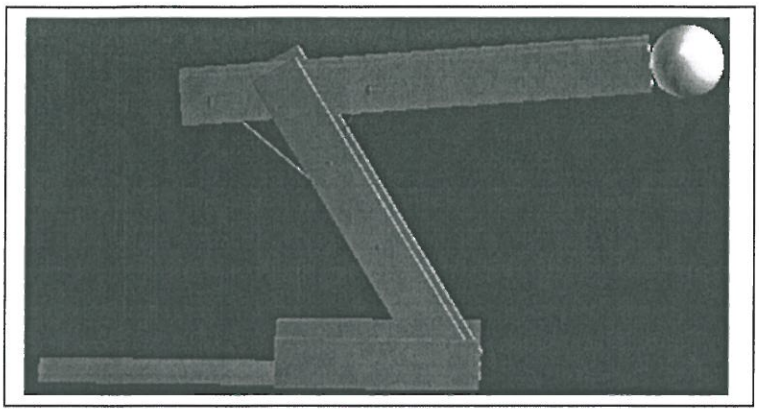
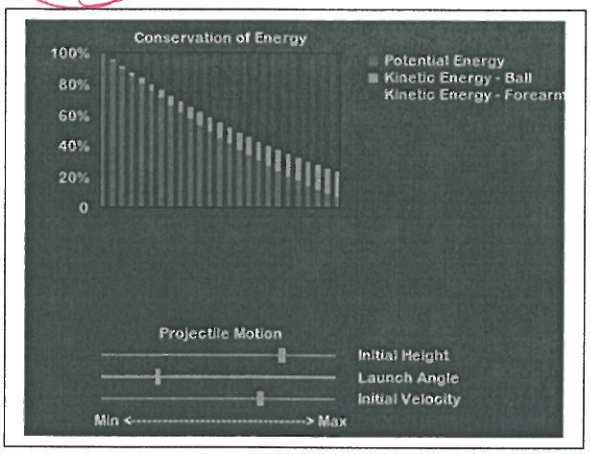
Part I. virtual model accuracy and precision

My model jacharr22 launches a ping pong ball the distance of 7.5m.



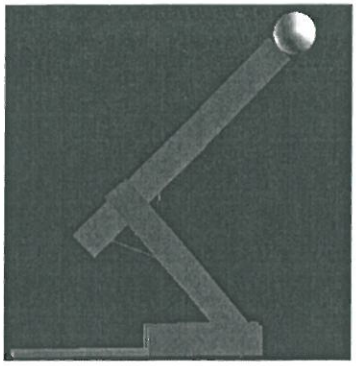


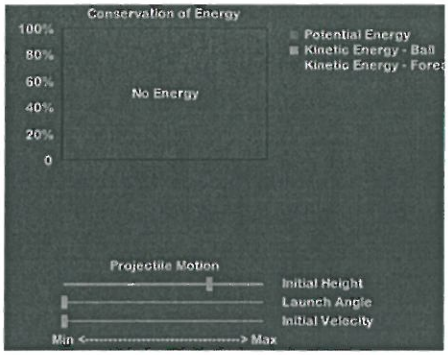
Design Specifications

Design Inputs	Minimum	Maximum	Designed
Arm Length	150 mm	225 mm	185.0 mm
Arm Angle	45 deg	65 deg	59.9 deg
Forearm Length	200 mm	250 mm	235.0 mm
Pullback Angle	--	85 deg	85.0 deg
Forearm Tricep Handle Offset	15 mm	40 mm	40.0 mm
Arm Tricep Handle Offset	30 mm	100 mm	90.0 mm
Forearm Bicep Handle Offset	15 mm	60 mm	40.0 mm
Arm Bicep Handle Offset	15 mm	60 mm	40.0 mm
Total Material Length	--	2000	1263.2 mm
Number of Rubber Bands	--	3	3

Part II. Design Evolution

jacharr4





This was one of my first designs. I thought that it would be best to have the arm and the ball at a higher angle, and I was trying a longer arm, so that it would have a high height throughout the flight. I thought that this would help the ball stay in the air longer and trave farther. I wanted to get the chart to be full of mainly green and blue. (Why?)

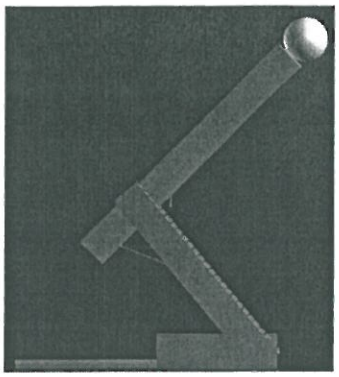
But, I then noticed that this did not work. It needed a bigger pullback angle to actually get the ball to go anywhere. I know this because it had no energy and went a distance of 0.00m. I also that it did not matter the pullback angle to have the ball at a certain height before it is actually launched, it would get there any way because of the arm length.

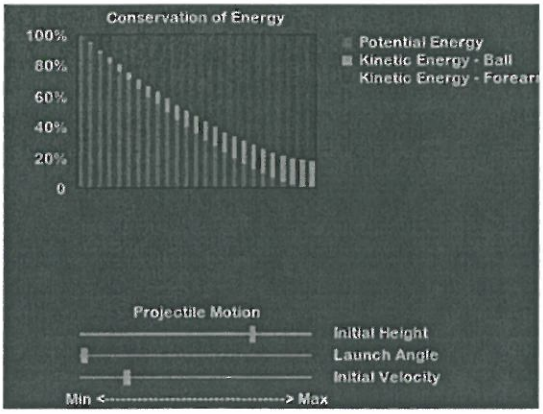
Also all of my rubber bands where set to 33, with two on the tricep and one on the bicep. Good

Design Specifications

Design Inputs	Minimum	Maximum	Designed
Arm Length	150 mm	225 mm	185.0 mm
Arm Angle	45 deg	65 deg	50.0 deg
Forearm Length	200 mm	250 mm	245.0 mm
Pullback Angle	--	85 deg	45.0 deg
Forearm Tricep Handle Offset	15 mm	40 mm	40.0 mm
Arm Tricep Handle Offset	30 mm	100 mm	78.0 mm
Forearm Bicep Handle Offset	15 mm	60 mm	40.0 mm
Arm Bicep Handle Offset	15 mm	60 mm	40.0 mm
Total Material Length	--	2000	1283.2 mm
Number of Rubber Bands	--	3	3

jacharr5





Using my background knowledge and looking at what happened with jacharr4 I made my arm length shorter and saw better results. The chart was mainly green and red. The ball went 1.55m, I was 6.33m from the target. But, I was still not hitting the target.

meaning?

My next thought was to raise the pullback angle. I wanted to get the launch angle and the initial velocity up.

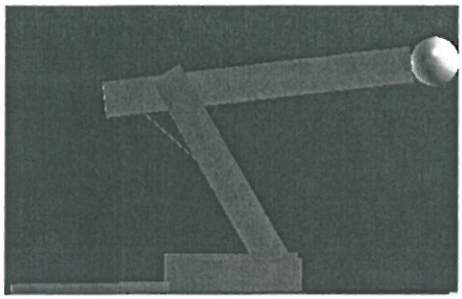
I used my maximum of three rubber bands. I had two rubber bands on the tricep that where set to 31 and one on the bicep that was set to 31.

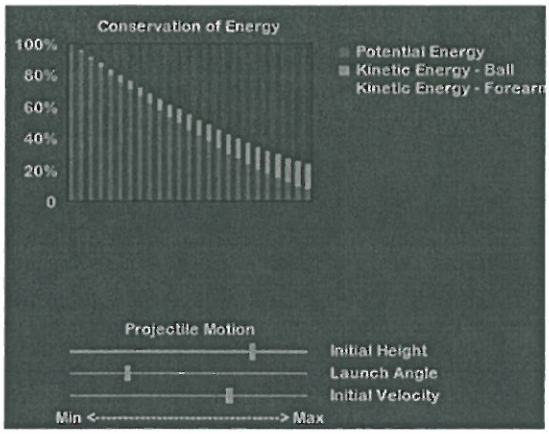
Good

Design Specifications

Design Inputs	Minimum	Maximum	Designed
Arm Length	150 mm	225 mm	185.0 mm
Arm Angle	45 deg	65 deg	50.0 deg
Forearm Length	200 mm	250 mm	235.0 mm
Pullback Angle	--	85 deg	45.0 deg
Forearm Tricep Handle Offset	15 mm	40 mm	40.0 mm
Arm Tricep Handle Offset	30 mm	100 mm	78.0 mm
Forearm Bicep Handle Offset	15 mm	60 mm	40.0 mm
Arm Bicep Handle Offset	15 mm	60 mm	40.0 mm
Total Material Length	--	2000	1263.2 mm
Number of Rubber Bands	--	3	3

jacharr16





With that arm I took the information that I had gathered from all my previous designs and made an arm that threw a ball a distance of 7.44m. But I was still 0.06m off from my target. ✓

I still was using three rubber bands, but this time I had two on the tricep that where set to a strength of 30. I also had one on the bicep that was set to a strength of 31. ✓

From this model I had to make slight changes to get it 0.06m closer.

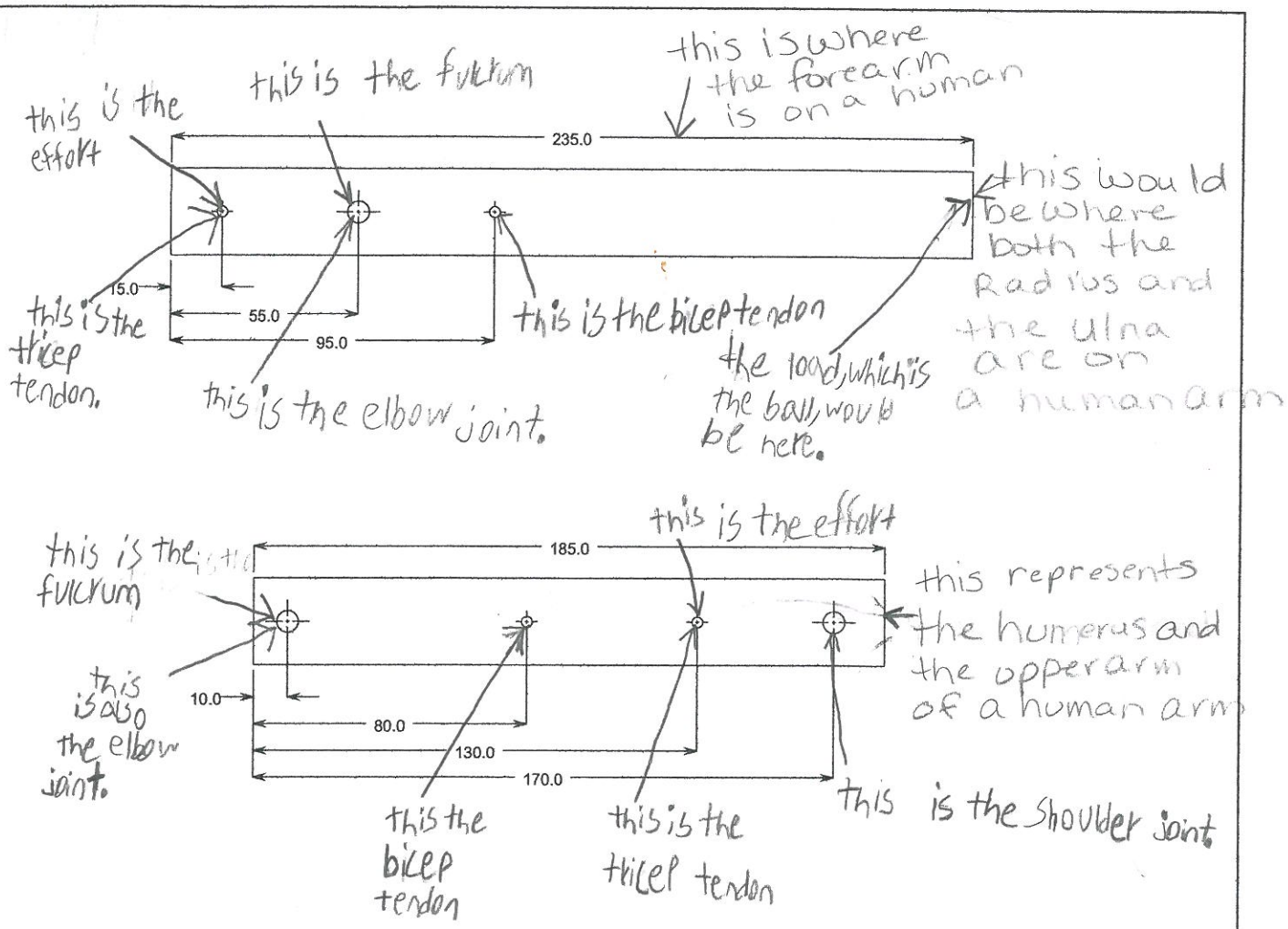
Good. Incremental changes, nice!

Design Specifications

Design Inputs	Minimum	Maximum	Designed
Arm Length	150 mm	225 mm	185.0 mm
Arm Angle	45 deg	65 deg	60.0 deg
Forearm Length	200 mm	250 mm	235.0 mm
Pullback Angle	--	85 deg	84.0 deg
Forearm Tricep Handle Offset	15 mm	40 mm	40.0 mm
Arm Tricep Handle Offset	30 mm	100 mm	90.0 mm
Forearm Bicep Handle Offset	15 mm	60 mm	40.0 mm
Arm Bicep Handle Offset	15 mm	60 mm	40.0 mm
Total Material Length	--	2000	1263.2 mm
Number of Rubber Bands	--	3	3

V. Schematic blueprint

model: Jacharr17



Notes: Cut two arms and two forearms

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Very nice!

Model: jacharr17

III. Potential Energy & Work Calculations

Work = 0.09 joules

IV. Kinetic Energy & Velocity Calculations

Velocity = 10.14m/s

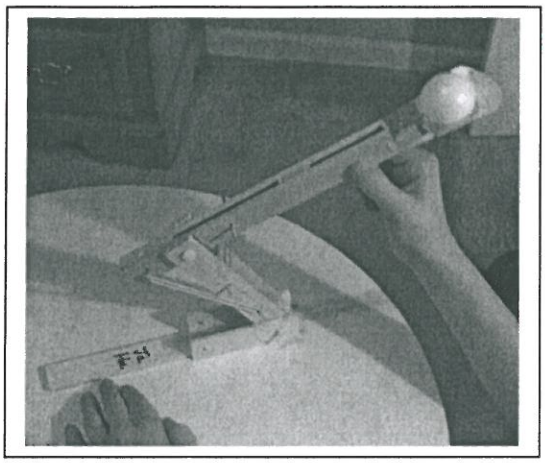
VI. Ballistics Predictions

I predict that my arm will launch the ball a distance of 7.50 meters. I think this because I have practiced with it.

Model: jacharr17

VII. Refinement of model

Through the process to get my prosthetic arm to throw a ball the distance of 7.50 meters I changed my real life model. Changes I made include changing the rubber band lengths, the rubber band strengths, the arm angle, and the pullback angle.



This was my original model. But the rubber bands where twisted so that it would throw further.

Why does that happen?

Rubber band strength	Tricep = 30 Bicep = 31
Arm angle	60
Pullback angle	85

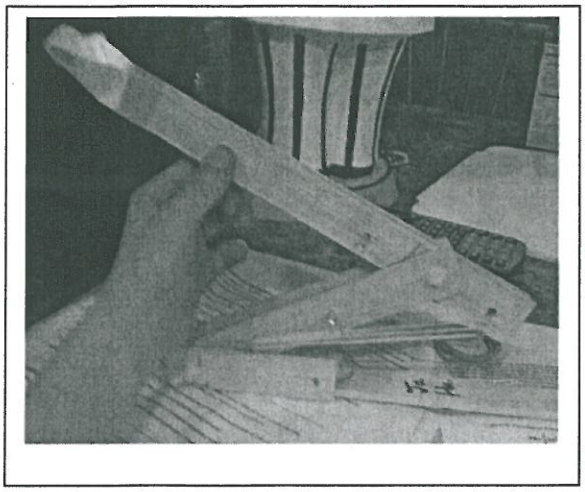
This arm threw the ball 4.5 meters.

Love the photos!

This was my first arm just with a few modifications. It was able to throw the ball 6 meters.

I kept everything the same except for the pullback angle.

Rubber band strength	Tricep = 30 Bicep = 31
Arm angle	60
Pullback angle	95
Distance thrown	6 meters.



This is my final model, it throws the ball a distance of 7.5 meters. I made the rubber bands stronger, I made the pullback angle bigger, and the arm angle smaller.

Nice. :)

Rubber band strength	Tricep = 33 doubled over Bicep = 31
Pullback angle	95
Arm angle	
Distance thrown	7.5 meters

X. Post-Analysis & Reflection`

Through this project there where many difficulties. Some of these would include having to be so precise, also we used balsa wood which is easy to break. When I made the online model I had to get the arm to throw the ball 7.50 meters. I kept getting it to go either 7.51 meters or 7.52, but after many attempts I eventually got it to where it hit the target. Then it came to building the actual arm. Some of the difficulties here would include that if you drilled a hole incorrectly you had to find a way to fix it or use a new piece.

Excellent

Methods to overcome these challenges would include being persistent. Don't give up. When you find something that has a positive effect, keep slightly changing whatever it is. Also when you are working with your real life model be gentle with it. If you are very careful with your arm, it is less likely to break. Also try not to get frustrated, it will most likely cause you to mess up more, and could possibly cause you to break your arm.

Good strategy: Incremental, Reiterative Design. :)

Some things that could account for the real life model not perfectly matching the virtual model would include air resistance, and human error. Air resistance will slow down projectiles. And human error would change how the arm throws, and how the ball flies. If you use the wrong rubber band that could cause the ball to go too far or not far enough.

Some lessons that could be taken away from this project and applied elsewhere would include how to construct things from blue prints, could be applied in construction. How to find the velocity could be applied in physics. Finding the trajectory of a projectile would be applied in sharp shooting, archery, baseball, and so on.

XII. Lever Identification

The arm, when it is in the pullback – launch position, is a class one lever. This is because the load and energy are on opposite sides with the fulcrum in the middle.

Great!