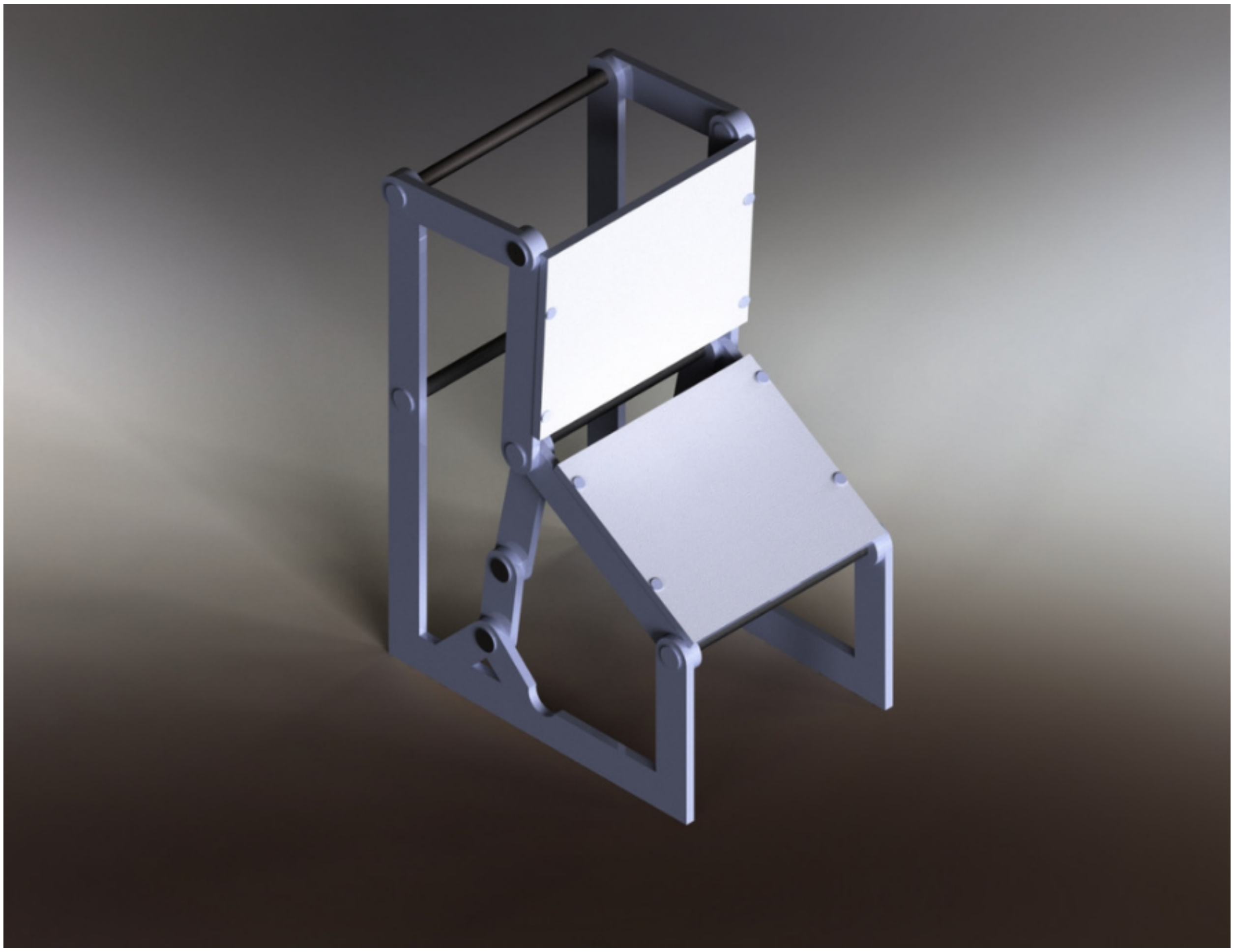

Electric Chair Lift Group 10
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ME 154
Ken Youssefi
05/15/2022

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Background

Many people struggle with standing up from a seated position. This impairment can be due to a multitude of reasons such as old age, disabilities, or knee injuries. To help combat this problem, we have created and designed an Electric Chair Lift that can assist people to easily and effectively stand up from a seated position. This is done by designing a chair that tilts the back seat up to increase the knee angle to a nearly standing position.

Task Assignment

Alireza Khoshnevis - Design & Manufacturing
Craig Haley - CAD & Presentation
Simon Delos Santos - CAD & Manufacturing
Cameron Reyes - Reports & Presentation
Jonathan Leodones - Electronics
Andrew Each - Electronics

Chair Lift Specifications and Requirements

Specifications

- Chair Weight: 60-70lbs
- Dimensions: 30in x 20in x 42in
- Leg Height: 12in
- Angle of Seat Tilt ≈ 40˚
- Constructed Out of .75in tube steel
- Seat Lift Speed: 1.67 rpm (4 seconds to reach 40˚)
- Weight Limit: 500lbs

Model Specifications

- Scaled to ⅙
- Constructed out of ABS plastic
- Dimensions: 5in x 3in x 7in

Requirements

- The chair must be comfortable to sit in for hours at a time
- The chair must be raised and lowered at a low speed
- The chair should be battery-powered
- The chair must be able to hold its position
- The chair must be easily maneuverable to move closer or further away from desks
- The chair must run off of one motor

- The chair must have easily accessible buttons to raise and lower the seat
- The chair should accommodate a wide range of heights
- The chair should be quiet

Conceptual Design and Free Hand Sketch

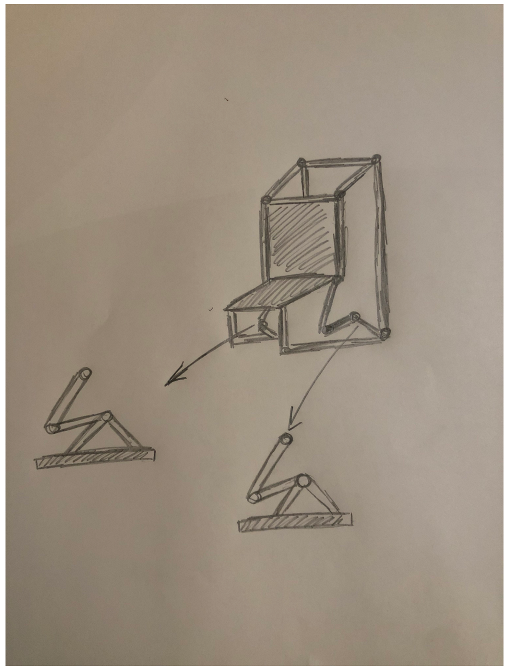


Figure 1: Initial Sketch of Electric Chair Lift

Above is our initial ideas for the Electric Chair Lift. As seen in the sketch above, we wanted to incorporate a four-bar mechanism to lift the seat of the chair from a flat 0˚ angle to approximately 40˚ so it is easier to stand up. Although these initial designs are slightly different from our final prototype, it gives a good representation and baseline of what we wanted our final prototype of the project to look like. In our initial phases of designing, we wanted to incorporate a couple of main design concepts. The first is to have a durable body so that the chair won't break down when a person sits on it. The second is a lightweight structure in comparison to other chairs in the industry. Typically, an industrial Electric Chair Lift weighs over 100lbs, therefore, we want our design to be lightweight at approximately 60 to 70 pounds. Lastly, we would also like our design to be easy to operate as the majority of people using the chair will be elderly or disabled. We would also like the chair to incorporate a couple of basic functionalities. The first is to be able to lift heavy weight as we don't want the chair to break down if multiple people or heavier individuals sit on it. The second is to be able to hold the weight for extended periods of time at both the fully extended and the fully contracted positions.

Introduction

Bill of Materials

Item #	Order Quantity	Part Name	Description
1	2	2-inch Link	3D Printed Driver Link
2	2	3.82-inch Link	3D Printed Coupler Link
3	4	4-inch Link	3D Printed Driven Link
4	3	6-inch Seat Link	3D Printed Supporting Link
5	2	Seat Rest	Square 3D Printed Seat Plates
6	3	Support Rod	3D Printed Supports for Chair
7	1	Chair Frame	3D Printed Base Frame for Chair
8	1	Raspberry Pi Pico	Runs user-written Python program to automate the motor movement and speed
9	1	DROK DC Adjustable Power Supply	Provides voltage to L298N Motor Driver and DC Motor SJ01
10	1	Solderless Breadboard	Connection points for the circuit
11	1	DC Motor SJ01	Controls link to move the chair lift
12	8	Connecting wires	Connects Raspberry Pi Pico to L298N Motor Driver and DC Motor SJ01
13	1	L298N Motor Driver	Bridges the DC Motor SJ01 to Raspberry Pi Pico

Diagram of Links

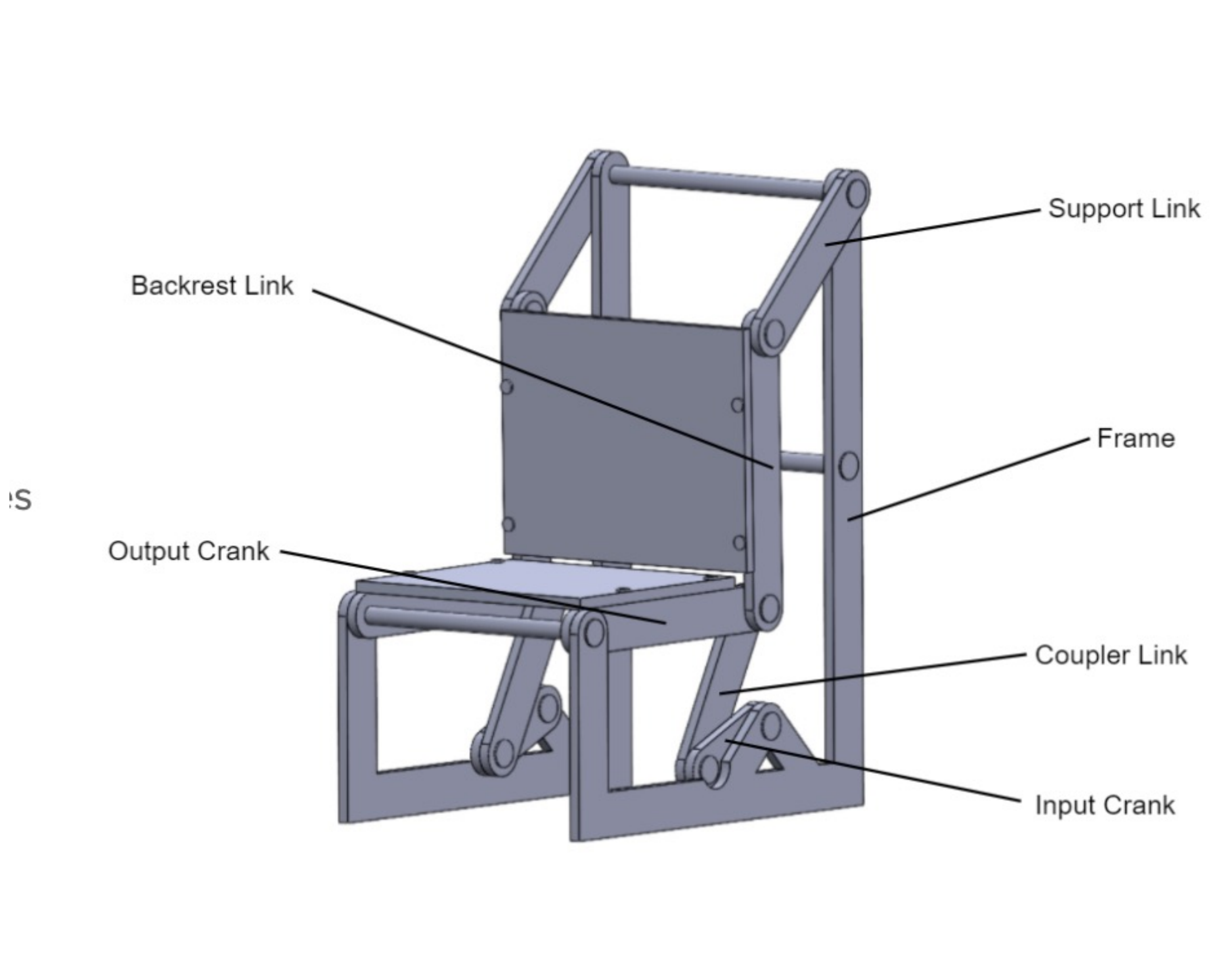


Figure 2: Labeled Diagram of Each Link

Description of Mechanism (4 Bar)

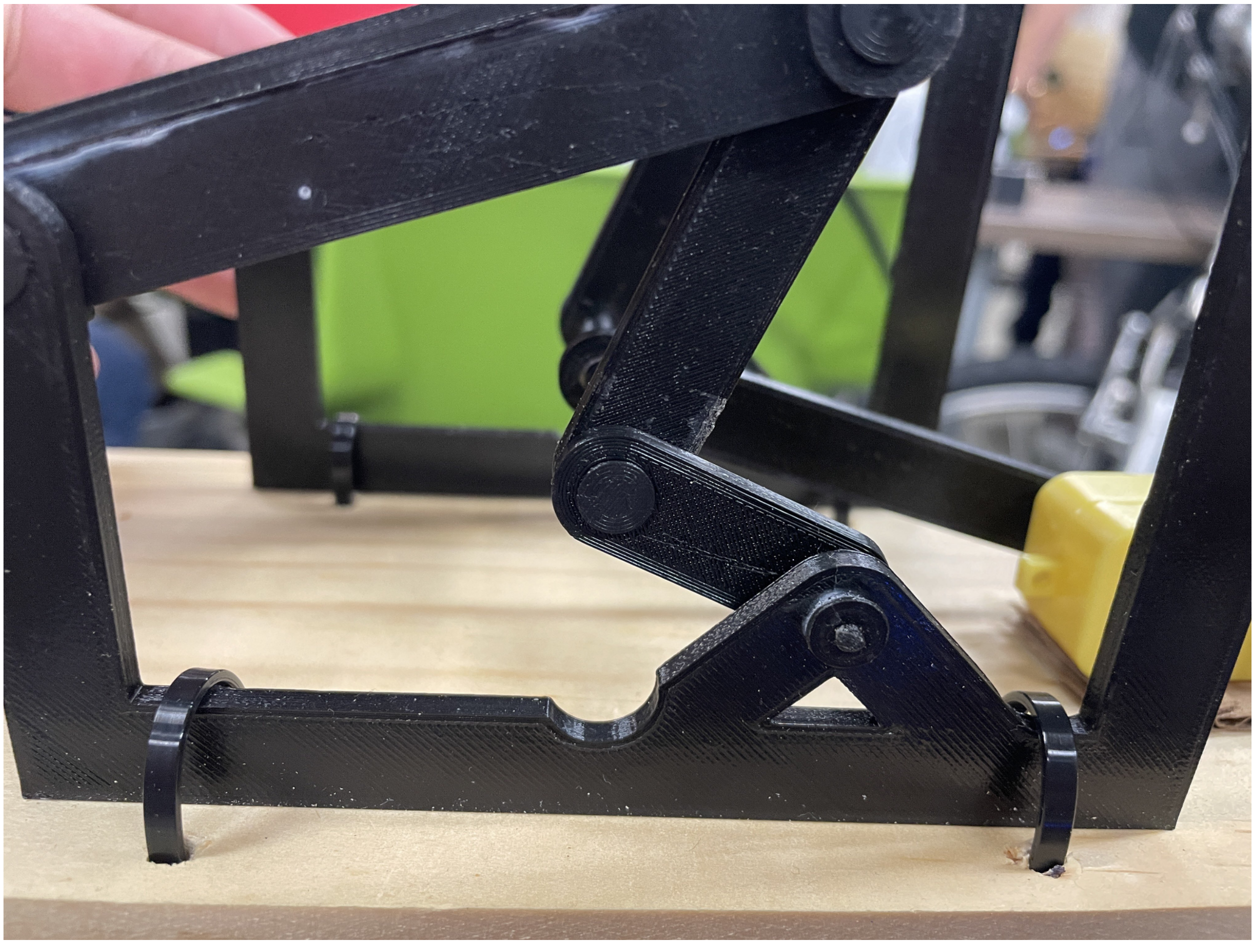


Figure 3: Side View of 4 Bar Mechanism

Our design involves the use of a 4-Bar Crank and Rocker Mechanism. This can be seen in the figure above. The driver link is the 2-inch link, the coupler link is the 3.82-inch link, and the driven link is the 4-inch seat link. In our design for the chair, we don't have the driver link rotate a full 360° but instead, we oscillate the driver link back and forth at 32.43° to allow our driven 4-inch seat link to fully extend and contract.

Electronics

The mechanism designed is intended to help people move from a seated position to a standing position while exerting as little force as possible. That should also mean the mechanism is simple to operate and user-friendly. It is achieved by using a motor to control the link that moves the seat by pushing a button. We are using a Raspberry Pi Pico board programmed with MicroPython that moves the link with an intended speed and goes back to its original position automatically. The circuit diagram showing the connection to the motor is shown below in *Figure 4* accompanied by the MicroPython code in *Figure 5*.

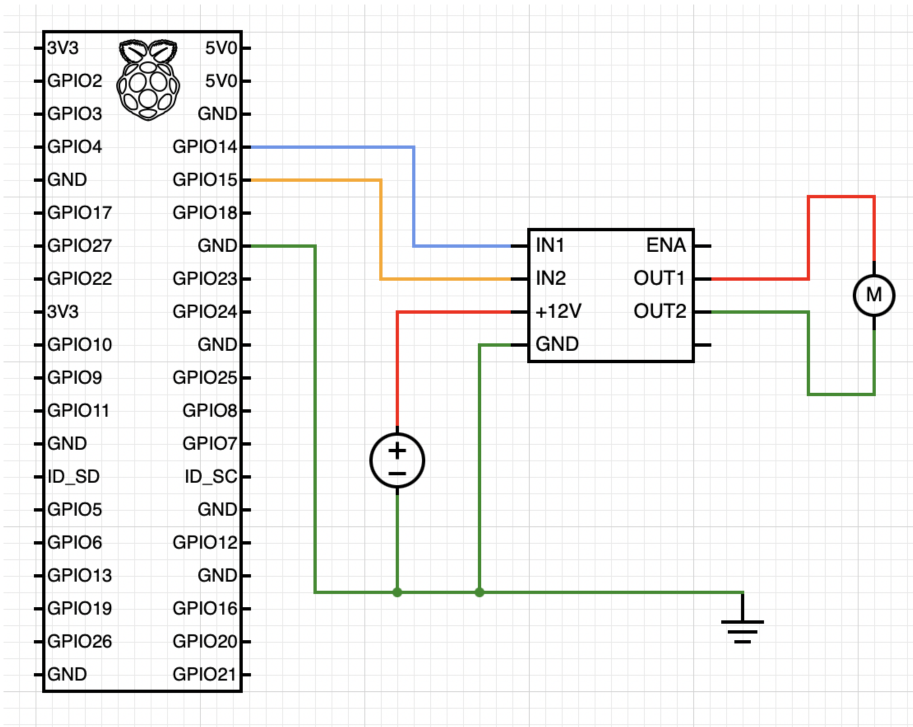


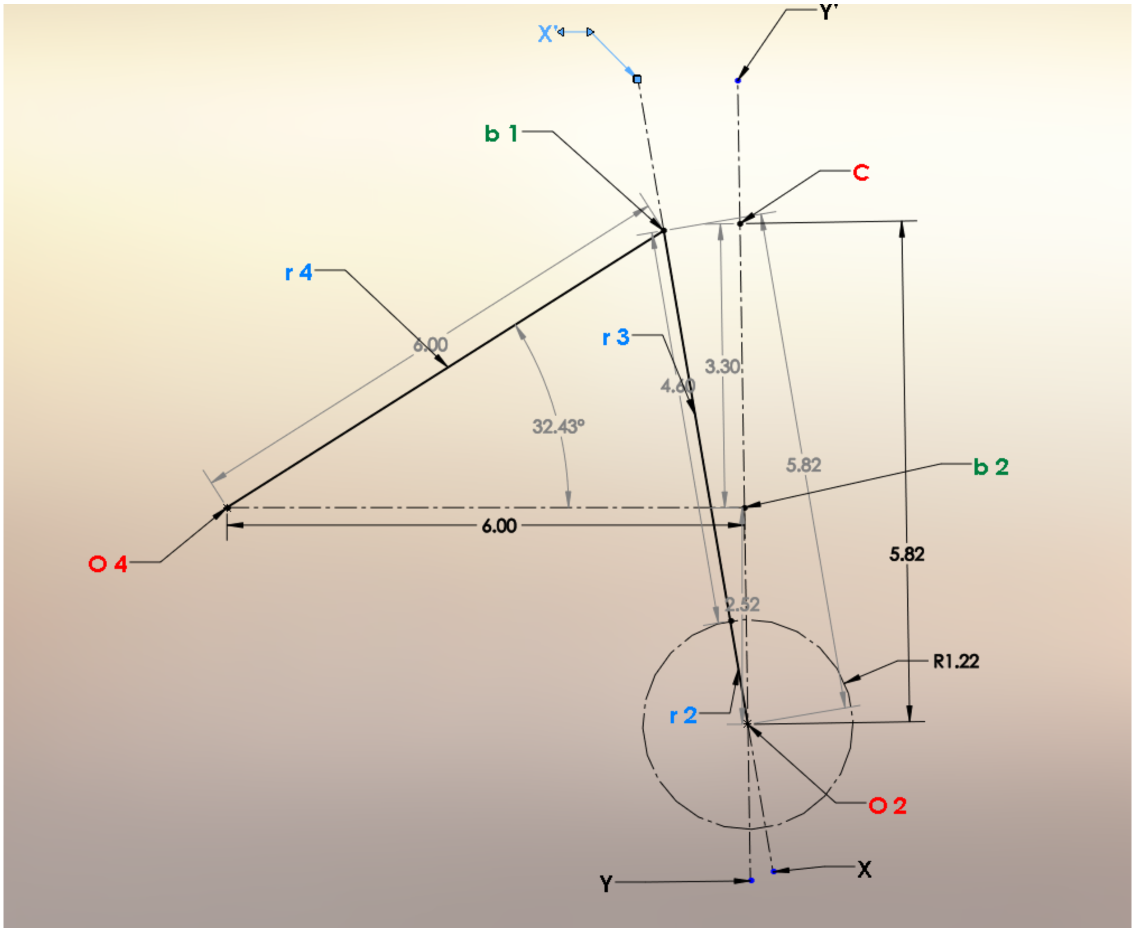
Figure 4: Circuit Diagram

```
from machine import Pin
from time import sleep
import utime

button = machine.Pin(20, Pin.IN, Pin.PULL_UP) #motor

motorIN1 = Pin(15, Pin.OUT)
motorIN2 = Pin(14, Pin.OUT)

while True:
    if button.value() != 1:
        #run at 4.85 V or 3.96 slowed

        #up
        motorIN1.value(0)
        motorIN2.value(1)
        utime.sleep(0.35)

        #hold
        motorIN1.value(1)
        motorIN2.value(1)
        utime.sleep(2)

        #down
        motorIN1.value(1)
        motorIN2.value(0)
        utime.sleep(.1)

        #hold
        motorIN1.value(0)
        motorIN2.value(0)
```

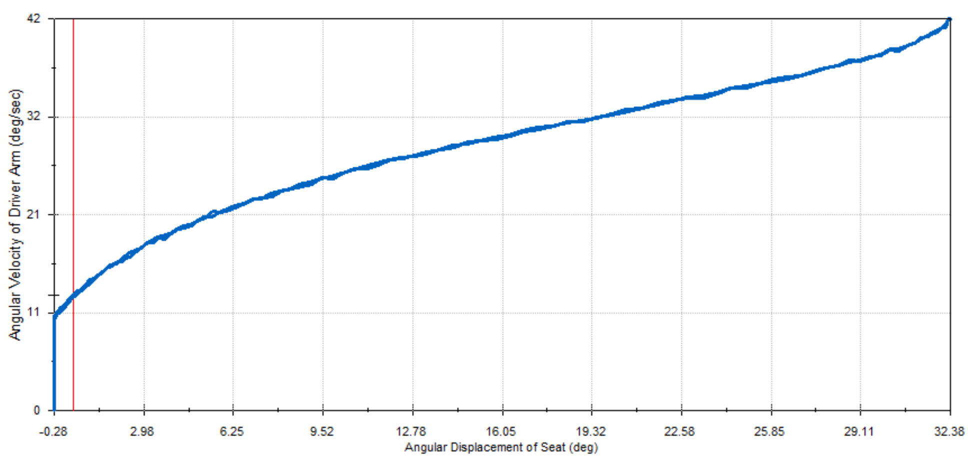
Figure 5: Motor Code

Detail Design

Graphical Synthesis

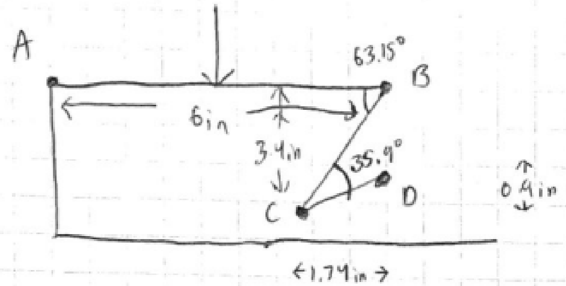


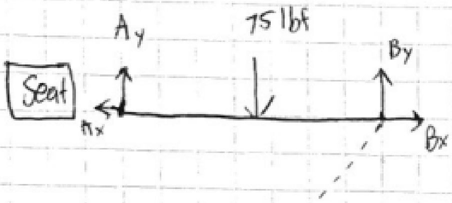
Kinematics Analysis



Kinetics Analysis

75 lbf (half of total weight, excluding support from seat itself)





$\Sigma F_x = 0$, ~~[illegible]~~ $B_x = A_x$

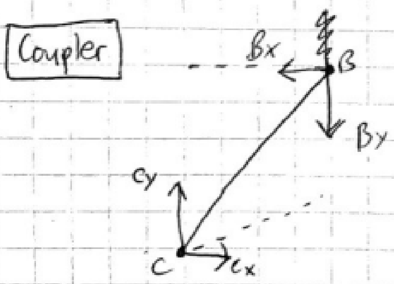
$\Sigma F_y = 0$, $B_y + A_y = 75\text{ lbf}$

$\Sigma M_{@A} = 0$, $6(B_y) = 3(75)$

$B_y = 37.5\text{ lb}$

$A_y = 37.5\text{ lb}$

$A_x = 19.19\text{ lb}$



$\Sigma F_x = 0$, $C_x = B_x$

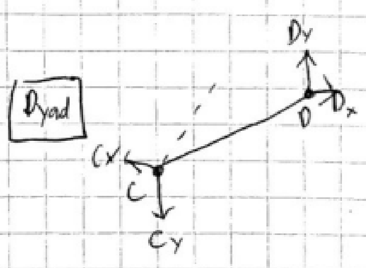
$\Sigma F_y = 0$, $C_y = B_y$

$\Sigma M_{@C} = 0$, $B_x(3.4) = B_y(1.74)$

$B_x = 19.19\text{ lb}$

$C_x = 19.19\text{ lb}$

$C_y = 37.5\text{ lb}$



$\Sigma F_x = 0$, $D_x = C_x$

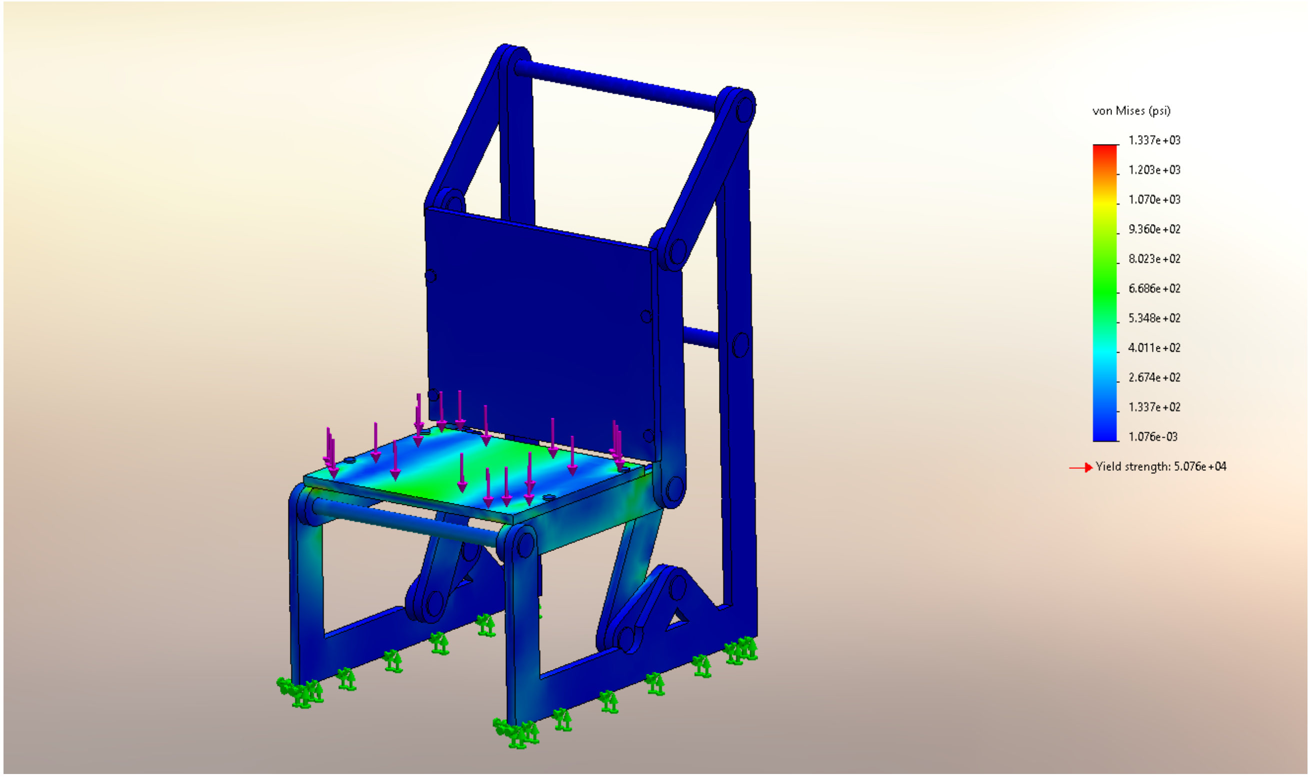
$\Sigma F_y = 0$, $D_y = D_x$

$\Sigma M_{@C} = 0$, $37.5(1.74) - 19.19(0.9) + T = 0$

$T = -63.5\text{ lb}\cdot\text{in}$

$T = 63.5\text{ lb}\cdot\text{in CW}$

FEA



$\sigma_1 = 1337$ psi
$\sigma_2 = 0.001076$ psi
$S_y = 50670$ psi

Animation of Mechanism

Exploded Animation

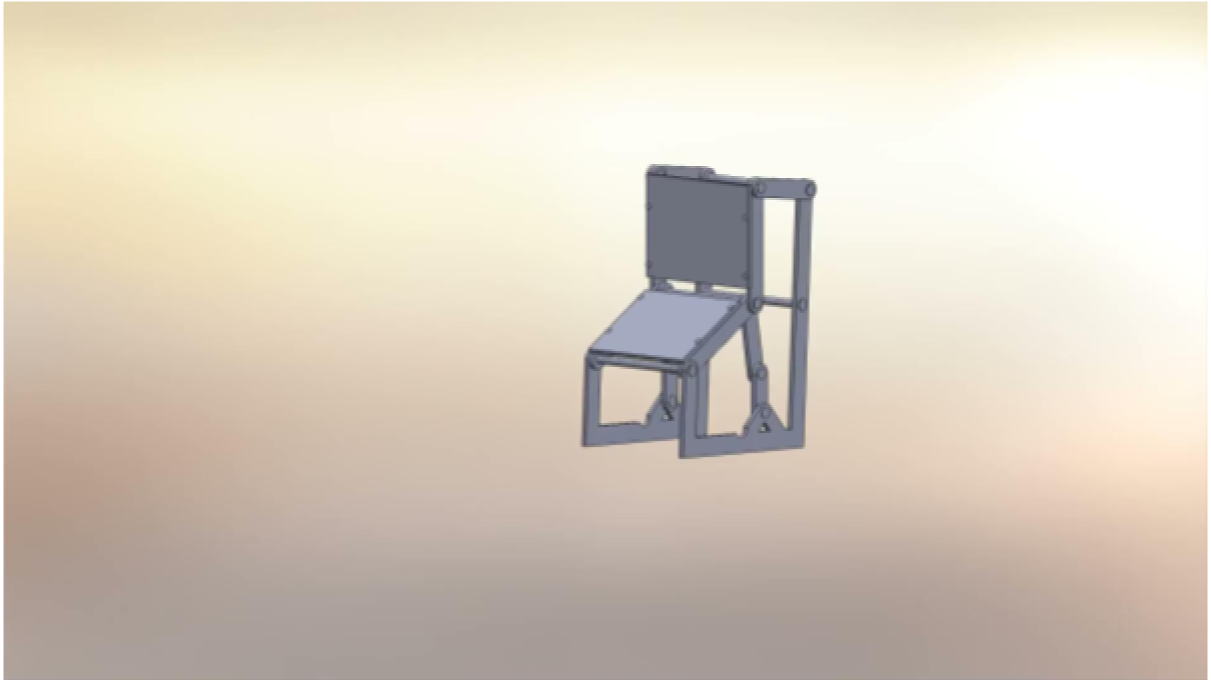


Figure 6: Explosion Animation

Youtube Link: https://youtu.be/andAeK86CIo

Animation of Mechanism

Figure 7: Mechanism Animation

Youtube Link: https://youtu.be/A4Y-LXv97gY

Drawings

3D Assembly

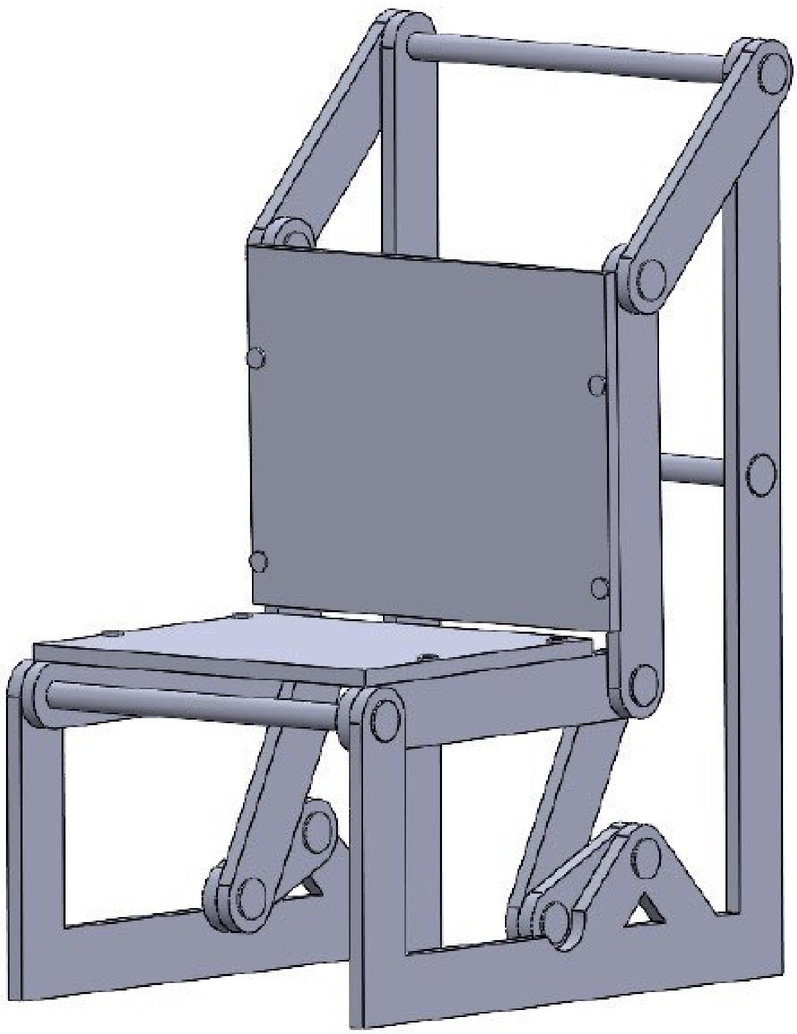


Figure 8: Final Assembly of Electric Chair Lift

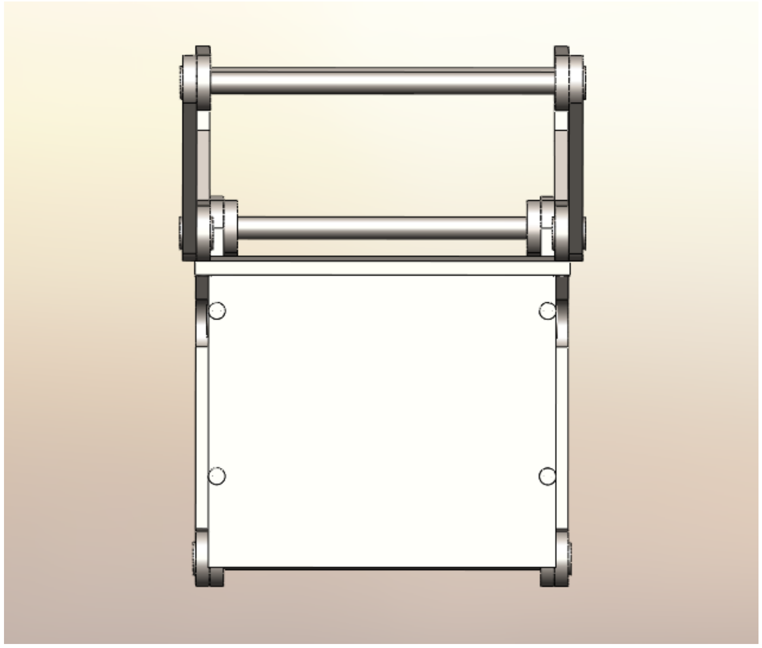


Figure 9: Top view of Electric Chair Lift

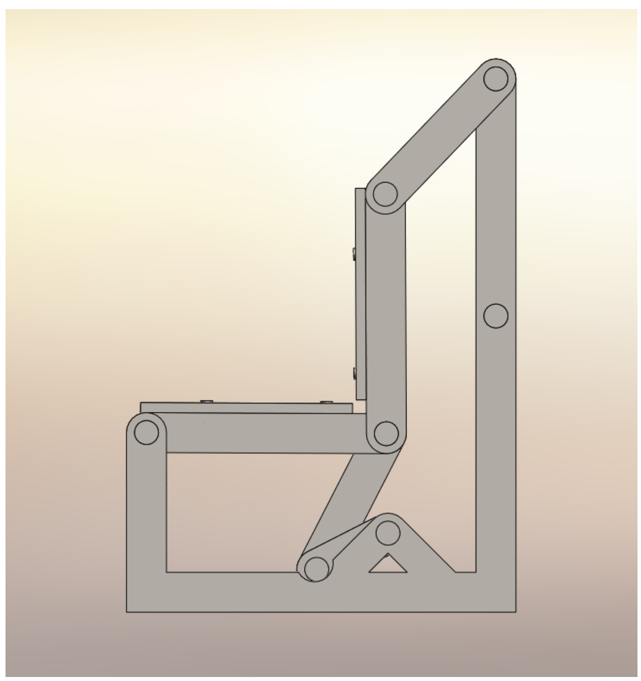


Figure 10: Right Side view of Electric Chair Lift

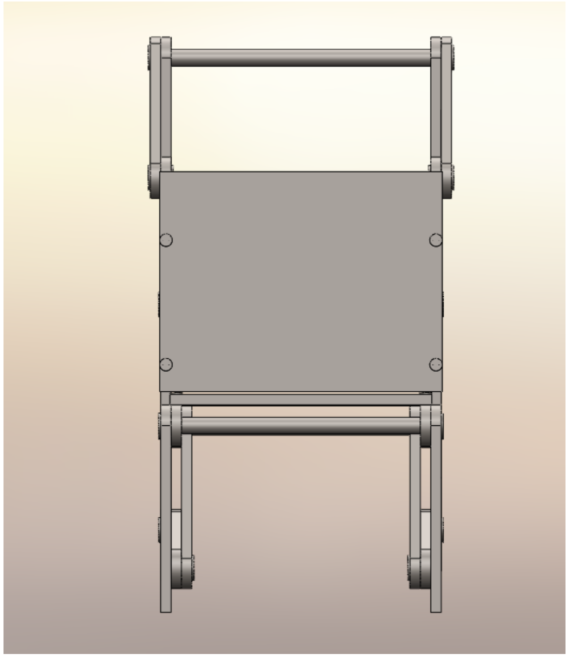


Figure 11: Front View of Electric Chair Lift

3D Exploded View

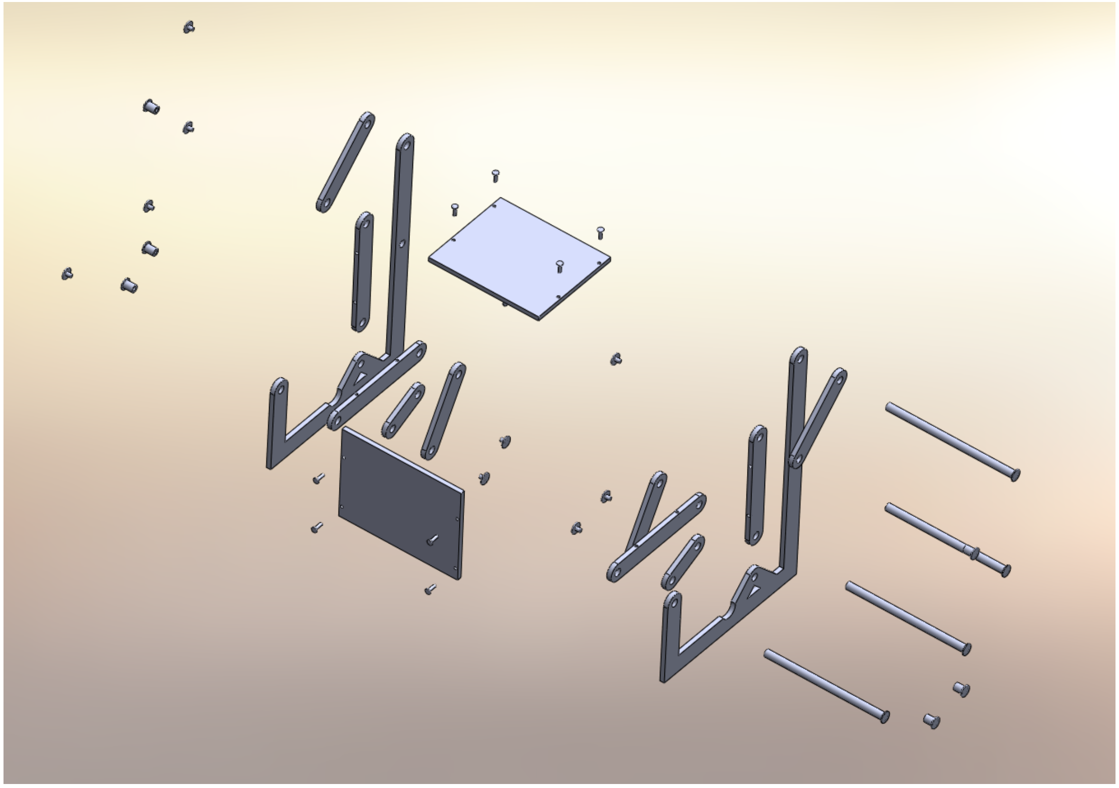


Figure 12: 3D Exploded View

2D Drawings

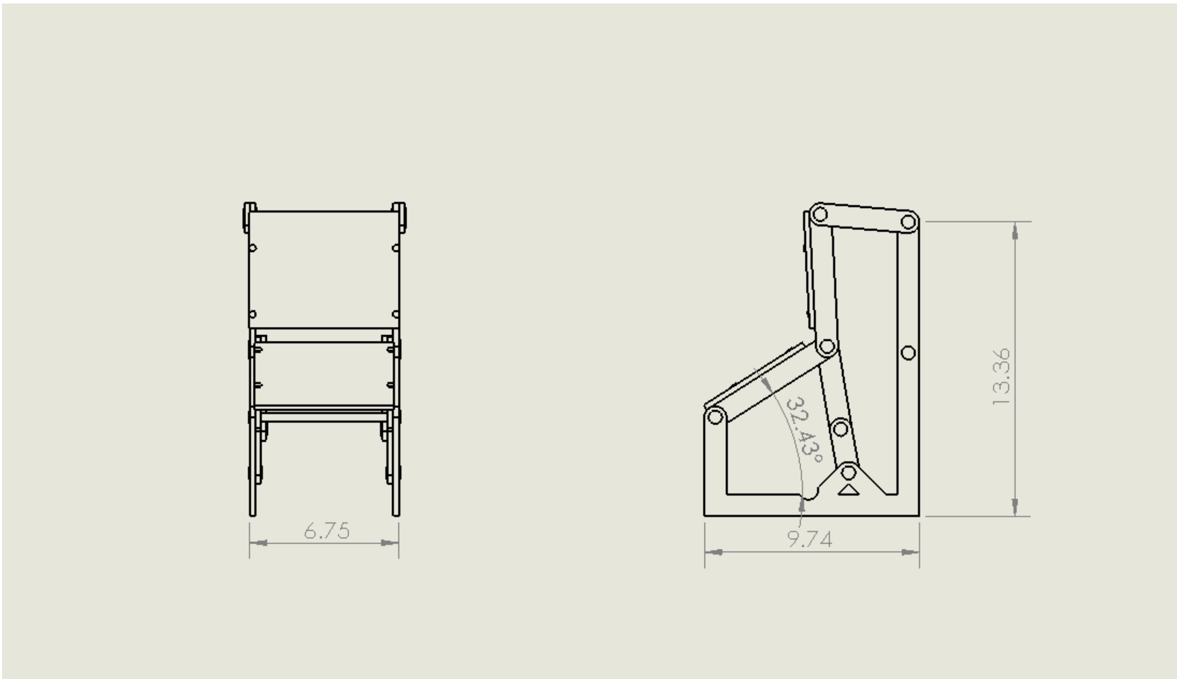


Figure 13:

Final Prototype Product

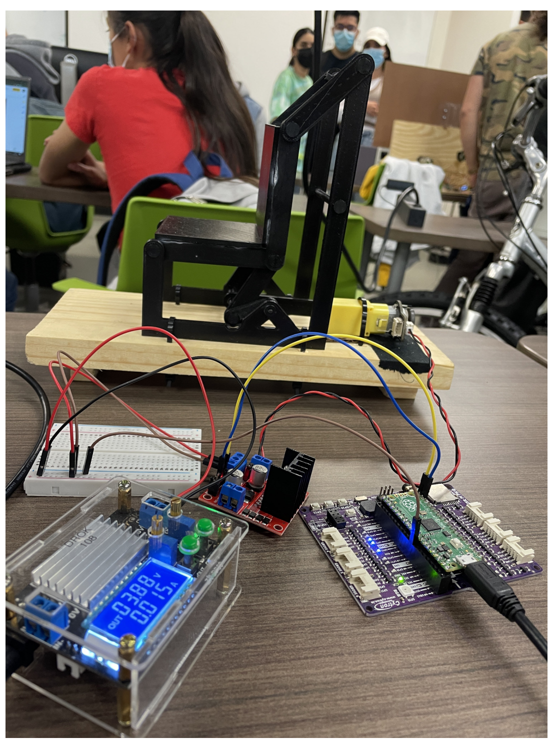


Figure 14: Electric Chair Lift Fully Contracted

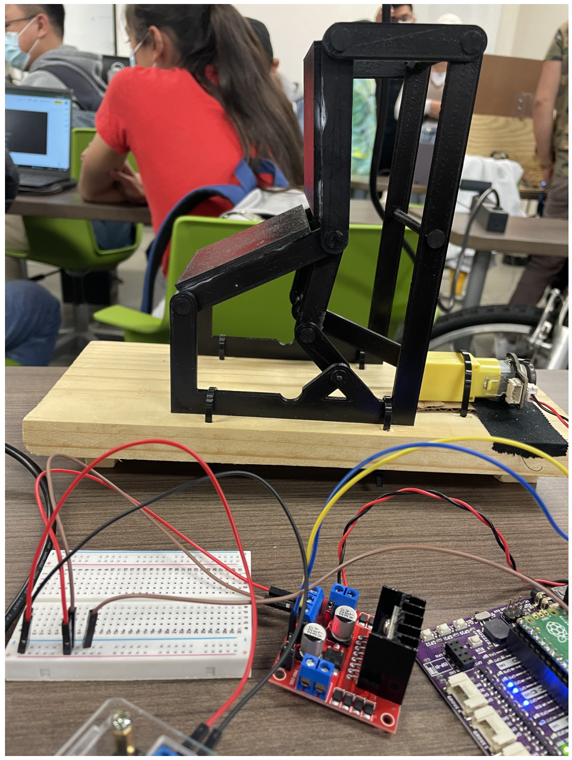


Figure 15: Electric Chair Lift Fully Extended

Product Demonstration Video

Youtube link: https://youtube.com/shorts/lfdv6SYT-nI

In our final prototype, we had to add an extra 6-inch link as well as a support rod that is not included in our CAD design. This allows for a place to attach our DFRobot DC Motor SJ01. We also installed a wooden base plate to give both the chair and the motor more stability. We attached both the chair and the motor to the wooden base using zip ties to ensure all the components would stay in place during the motion of the link.

Discussion and Future Modifications

Although our prototype operates at a good standard, there are some shortcomings. The backseat cannot recline as it can only be positioned at a 90-degree angle. The seat tilts enough causing the seat height itself to be too low. Lastly, there is not enough seat support for the overall current design. Given more time, some future modifications that we would like to make would be adjusting the backrest to an 80-degree angle, moving the dyad to the rear to accommodate extra seat support, and increasing the seat height to 19 inches.

If our chair lift design were to be put into production, we would want to include features that improve its usability, safety, and practicality. The first thing to do would be to add a hydraulic cylinder that would allow for less stress on the model to sustain the motor and link’s longevity. It would be placed directly under the seat to be a support while it moves to its different positions. In addition, a stepper motor would replace the current DC motor that is being used for the prototype. The stepper motor is the preferred motor for a production model because the higher torque is necessary to support the weight of the user and the full-sized linkages. It can also be programmed to control the angles and speed of the chair lift to make sure the user will have a sufficient amount of time to get up from the seat. The current prototype requires a button press on the microcontroller to move the chair from the seated position to the desired position. Adding a sensor to automate the process as soon as the user reaches the seat will remove the action and make it easier to tuck away the electronics in an enclosure. The last set of improvements that would be added to the chair would be to improve the ergonomics of the chair. The seat shape would be adjusted to have more curves to make it more comfortable to sit on for longer periods of time. Armrests and wheels would be considered as well to allow the chair lift to be used in a variety of situations, such as in offices and schools.

Reference

R.L Norton, “Machine Design”, 5th or 6th edition, Prentice Hall, (MD)