PEDAL LIFTING MECHANISM: DELIVERABLE D

Submitted by
B01, Team 11

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ABSTRACT

This is a technical document that informs the reader about the deliverable D for the project of student engineers in the class GNG2101 section B1. In this deliverable and document, the main purpose is to come up with a detailed design and a bill of materials (BOM), then with this information the students should come up with and finish prototype 1.

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1. INTRODUCTION

In this deliverable our team will provide design details for our concept and build a prototype to test the product's most critical functionality and target specifications. We will then use the prototype to provide the client with valuable feedback. Next, we will provide an estimated bill of materials and parts (BOM) for our final prototype.
For the first part of deliverable D, our team summarized the client feedback that we received during the second meeting and stated what needs to be changed or improved in our design. Then we defined the most critical product assumptions such as the acceptable values, availability of material, and critical functionality. This will help guide the team to create a more comprehensive prototype. This deliverable also outlines what the team intends to present to the client, and what information we would like to gather at our next client meeting.

*Note: This is the introduction from before we changed the project direction.

2. CLIENT MEETING TWO

Since our second client meeting was regarding the wheelchair suspension design, this section will outline the information gathered from Jasen (TA from the other course section) regarding the new wheelchair embarkment and dis-embarkment project plan.
To summarize the problem, on the front of the wheelchair, there are 2 peddles used as footrests while the user is in the wheelchair. To get on and off the wheelchair, the user must lift and lower the peddles by hand. This is difficult for the client as the peddles are very low to the ground forcing them to bend over causing some discomfort.
The client would like to be able to lift and lower the peddles with the press of a button to alleviate the strain it requires to move them manually. The client can move their legs out of the way when raising the peddles while sitting in the wheelchair. As such, the solution must be able to lift and lower the pedals to aid them embarking and dis-embarking the wheelchair.

3. UPDATED DESIGN

The new design consists of 3D printed parts, a 3-position rocker switch, a battery, a DC linear actuator, wires and nuts and bolts as required.

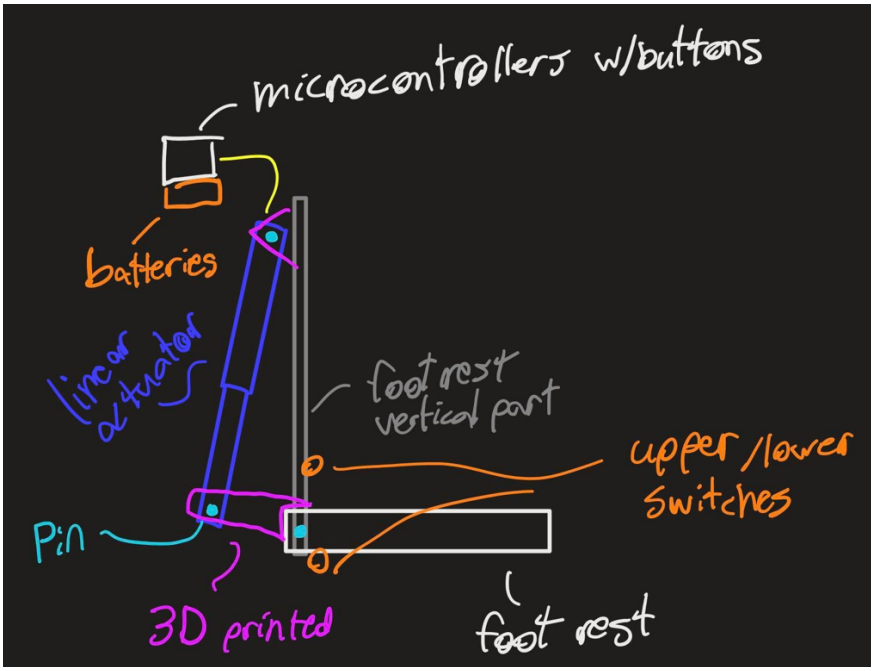

Figure 1: Updated design concept

4. PROTOTYPE

4.1 CAD Model

The below is a CAD model showing the piston and the basic principle which will be used to move the pedals up and down.

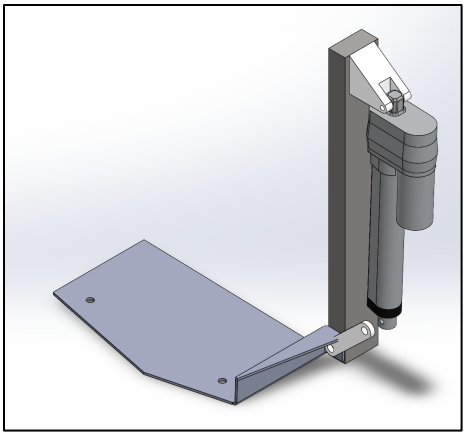

Figure 2: Actuator Mechanism

The following two images represent the raised and lowered positions of the pedals from the side.

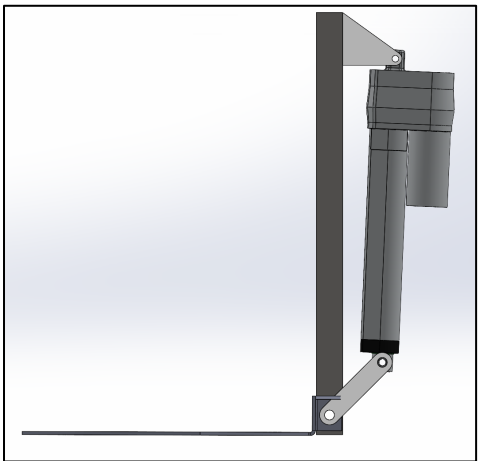

Figure 3: Lowered Position

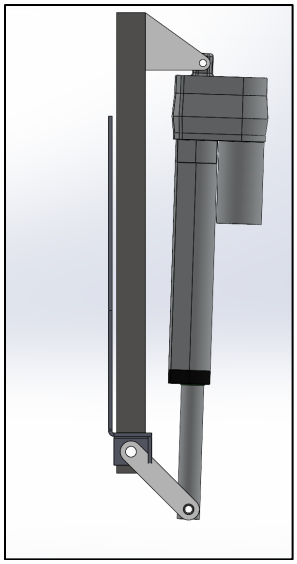

Figure 4: Raised Position

4.2 Calculations

$$Scale = L/L'$$

Where,

L (true length of wheelchair) = 1016 mm
L' (measured length of wheelchair) = 240 mm

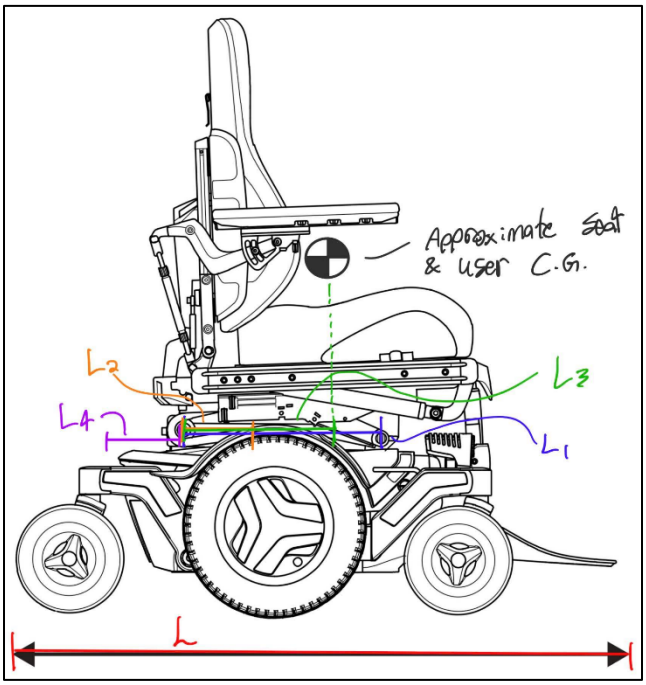

*Figure **5**: Wheelchair with various lengths [1]*

Using this scale, any measurements taken on screen could be scaled up to approximate the real distances of said measurements. The table below shows the various measurements taken as well as their scaled approximate real values. L is the total length of the wheelchair; this real value is given and was used to create the scale as per the sample equation above. L1 is the approximate distance between the slider pin in its rear-most position and the reclining piston. L2 is the approximate length of the slider. L3 is the approximate horizontal distance between the slider pin in its rear-most position and the center of gravity of the user and chair combined [2]. L4 is the approximate distance between the pin in its rear-most position and the approximate location of the spring. These distances will be used to find an appropriate spot for the battery to be mounted.

Table I: Measured and approximated real dimensions of key distances on the wheelchair

Length ID	Screen measurement (mm)	Approximated real distance (mm)	Approximated real distance (in)

L	240	1016	40
L1	80	339	13.35
L2	30	127	5
L3	35	148.2	5.83
L4	30	127	5

The following calculation was done to find the length of the member between the pedal pin and the linear actuator. This value was calculated assuming the pedal would be rotating 90º between its raised and lowered positions as well as for a stroke of 4".

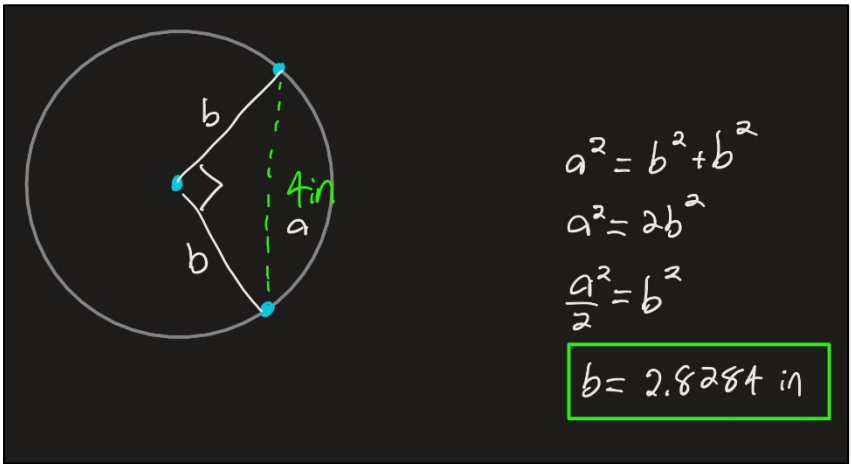

Figure 6: Length of member between pedal pin and linear actuator

The below image is a sample calculation which was used to find the required force to move the pedals. It is estimated that the required force to pull up each pedal is about 3 lbs. This would add up to 6 lbs as a combined load, though a value of 10 lbs was used to be conservative. Due to not having access to real measurements, the length of the pedal was estimated to be 12" from the end to the pin from which they rotate. Using the length b from the calculation above, the estimated required force to move the pedals is roughly 45 lbs, conservatively.

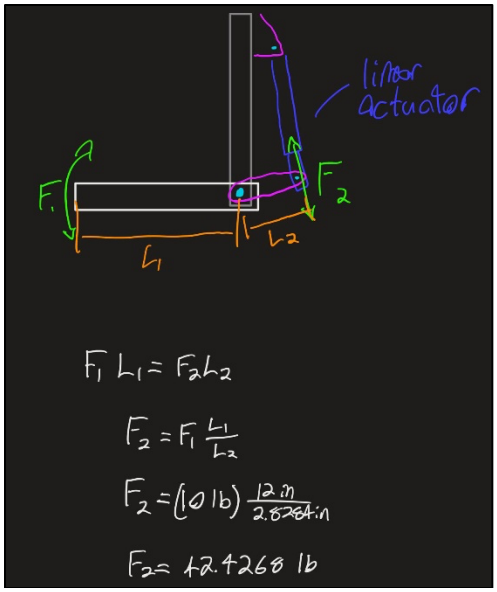

Figure 7: Force required to raise and lower pedals

5. TARGET SPECS

Table II: Target specifications

Design Specifications	Relation (=, < or >)	Value	Verification Method	Design Specifications
Functional Requirements				
Load capacity (lbs.)	>	15	Test	Load capacity
Time of assembly/modification (mins)	<	60	Test	Time of assembly
Constraints				
Cost ($)	<	100	Estimate	Cost
Project deadline (months)	=	3.5	N/A	Project deadline
Non-Functional Requirements				
Customer satisfaction (rating 1-10)	>	7/10	Analyze	Customer satisfaction

Table III: Linear Actuator Specifications

Metric	Units	Values
Rated Load	Pound Feet [Lbs-ft]	330
Dimensions	Inches [in]	10.39" x 3.70" x 2.13"
Protection Class	IP rating [IP##]	IP54
Item Weight	Pounds [Lbs]	2.29
Stroke Length	Inches [in]	4"
Retracted Length	Inches [in]	8.07"
Extended Length	Inches [in]	12.01"
Input Voltage	Volts [V]	12
Power type	N/A	DC
Max Push Load	Pounds [Lbs]	330
Max load	Pounds [Lbs]	330

Max Pull Load	Pounds [Lbs]	264
Travel Speed	Inches/second [in/sec]	0.22
Operation temperature	°C	Between -26 and +65
No-load current	Amperes [A]	0.8
Max load current	Amperes [A]	3

*A product with an IP54 rating is protected against quantity of dust that could interfere with the normal operation of the product but is not fully dust tight. The product is completely protected against solid objects. It is also protected against water splashing from any angle [15].

6. TESTING PLAN

For prototype 2, we plan on verifying the model can hold the target weight of 15lb and retract from 0 to 90 degrees multiple times to ensure the prototype can lift the peddles.
For the prototype 3, we plan on testing that the model can function on supports that resemble the client's chair. If we can test the design on the client's chair then that we will; however, if that is not possible, we will create mounts to simulate the working model on the client's chair.

7. PRELIMINARY BILL OF MATERIALS (BOM)

The following is the BOM in its current state. As the project progresses, this table will be developed and become more finalized.

Table IV: Preliminary Bill of Materials

Material	Place	Link	Cost per unit	Number of units	Total cost (CAD)
Linear Actuator	Amazon	Actuator	$67.39	1	$67.39
3 Pin Button Switch	Amazon	Button	$16.99	1	$16.99
12V-5Ah Battery	MakerLab	Battery	$1.00	1	$1.00
3D Printer Filament	MakerSpace	N/A	$0.00	0	$0.00
22awg Electric Wire (5ft)	MakerLab	Wire	$2.50	2	$5.00
Lead-Free Solder Wire (4oz)	Patrick's Place	Solder	$0.00	1	$0.00
Scrap Acrylic	MakerSpace	N/A	$0.00	2	$0.00
Bolts	Canadian Tire	Bolt	$2.29	1	$2.29
Nuts	Canadian Tire	Nut	$0.17	3	$0.51
Rubber Mats	Amazon	Mats	$8.72	1	$8.72
Zip Ties	Patrick's Place	N/A	$0.00	4	$0.00
*Tax not included in price			**NET COST:**		**$101.90**

8. PROJECT PLAN

This section contains the status of Wrike.

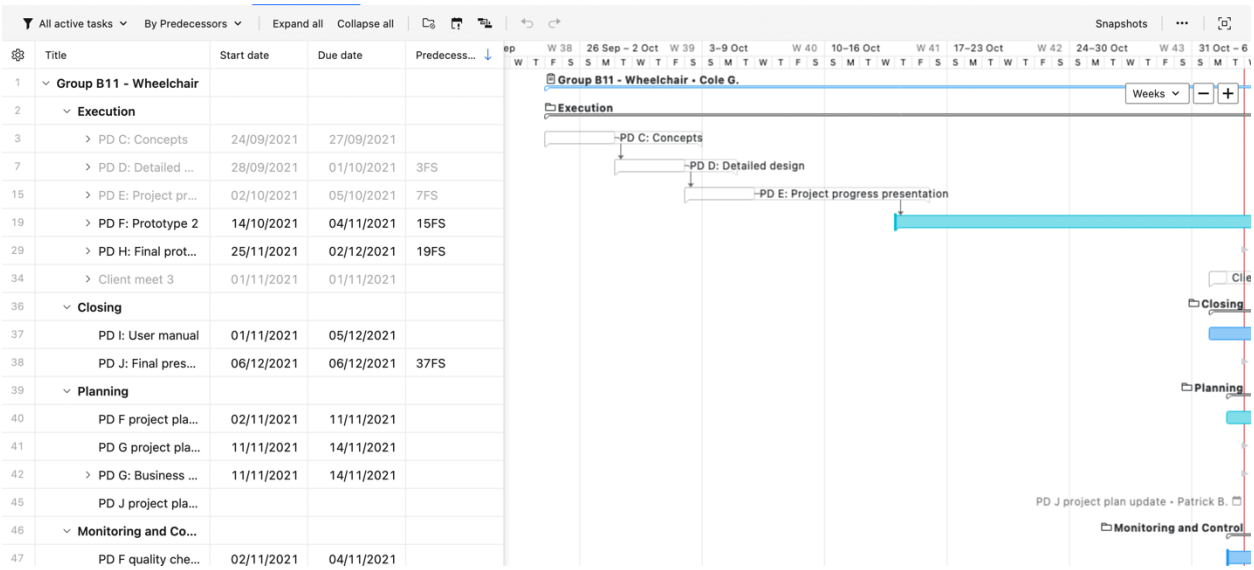

Figure 8: Wrike screenshot 1

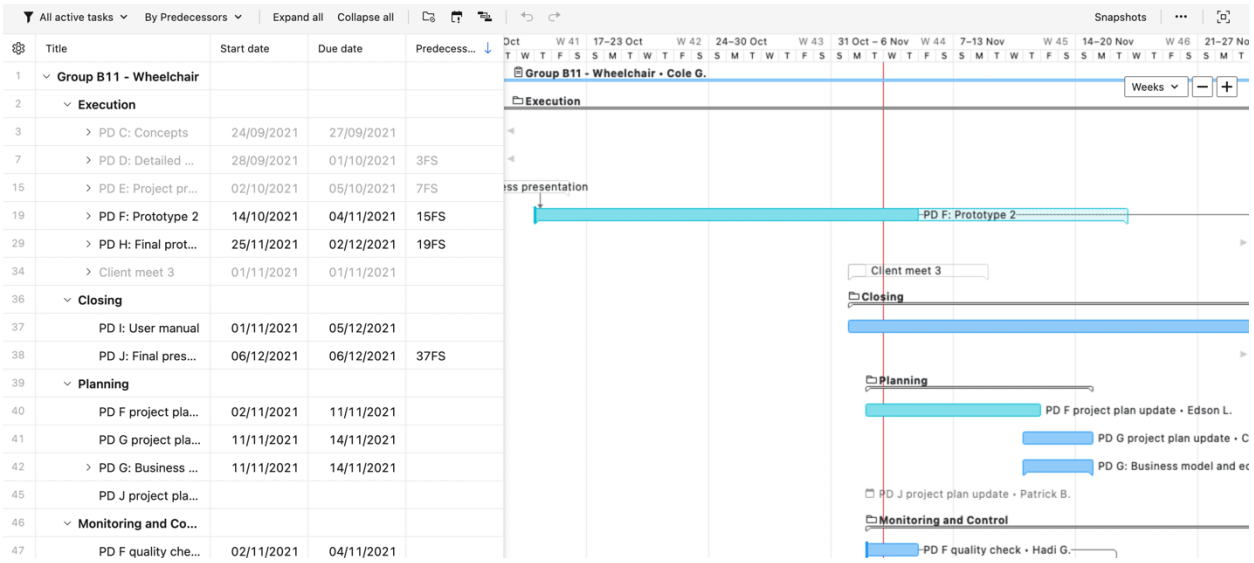

Figure 9: Wrike screenshot 2

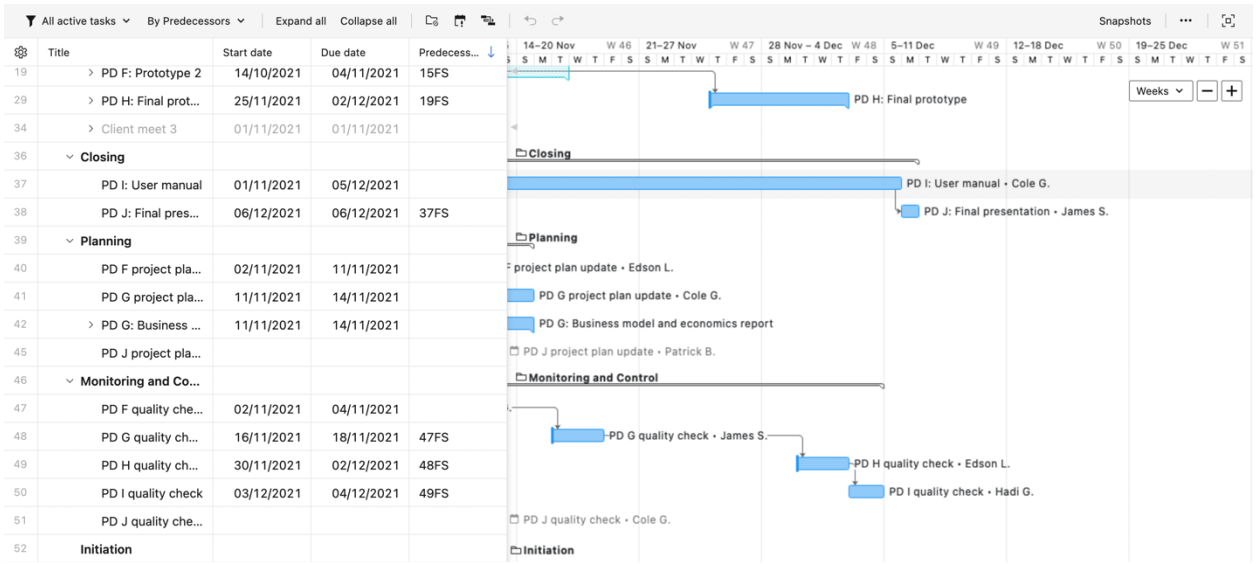

Figure 10: Wrike screenshot 3

Since the last deliverable the scope of the project has changed. The project now focuses on designing a system to lift the foot pedals on the client's chair. The design of prototype 2 had been redone during the reading week along with the formation of the bill of materials. As a result, the assembly of prototype 2 will be pushed back. This date is pending the approval of the bill of materials and the shipping dates of the components. If all goes according to plan the due date of prototype 2 might be late, however we should be back on track for the rest of the deliverables after prototype 2 is submitted.

9. REFLECTION

In this deliverable, the comments gathered from the second client meeting were considered when making final adjustments to the design concept. With the design finalized, the prototyping phase began with creating a 3D model of the design in Solid works. Since the first prototype was an analytical model, hand calculations were done to ensure that the system can withstand the maximum amount of force (250lbs) as specified in the target specifications of deliverable B. A preliminary bill of materials was also created based on the final design.
With the first round of prototyping completed, preparation for the next client meeting started with the focus being on the initial prototype and the calculations completed. Lastly the Wrike was updated for the next two weeks adding subtasks to help guide the following deliverables. The next deliverable will consist of a group presentation regarding the progress of the project. With a round of prototyping completed, the group should summarize all parts of the project thus far with a slight emphasis on the prototype as well as its testing.

10. REFERENCES

[1] Permobil, "M3 Corpus user manual," 09 07 2020. [Online]. Available: https://www.permobil.com/us/wp-content/uploads/2020/08/M3_Corpus-User_manual-eng-US-v1-337261.pdf. [Accessed 28 9 2021].

[2] "Determination of centers of gravity of man," 08 1968. [Online]. Available: https://www.faa.gov/data_research/research/med_humanfacs/oamtechreports/1960s/media/AM62-14.pdf. [Accessed 3 10 2021].