PEDAL LIFTING MECHANISM:

DELIVERABLE F

Submitted by

B01, Team 11

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ABSTRACT

This is a technical document that informs the reader about the deliverable F for the project of student engineers in the class GNG2101 section B1. The purpose of this document was to test prototype 2 and use the feedback given from the client to produce a more meaningful design.

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1. INTRODUCTION

In this deliverable, *Prototype II and Client Feedback*, it is requested to outline a prototyping test plan as well as develop a prototype that will undergo tests and achieve the objectives set by the team. These tests and objectives will be represented with the help of a table. Stopping criteria will also be defined for each objective to be satisfied with the prototype's performance. A simple analysis of these objectives will be included in the deliverable. The final requirement for this deliverable is to collect feedback and comments from different potential customers (if possible) to improve the product.

2. CLIENT MEET

During this meeting, the client was presented with the new project direction. The client liked the concept but had some concerns that needed to be addressed. One of the biggest concerns is that the height of the foot pedals is adjustable, and that the client alters their height frequently. As such, the design should be slightly modified to allow for the linear actuator to function as intended if the height of the pedals is adjusted. Another concern the client had was that their wheelchair technician must be the one to install our mechanism onto the chair to prevent voiding the chair's warranty. This requires that the installation of the mechanism be simple enough to allow the technician to install this mechanism without too much difficulty and confusion. The last concern the client mentioned was the placement of the switch to raise and lower the foot pedals. The client requested that the switch be on the left arm rest, and for it to be at a similar distance to the control pad on the right arm rest. The switch mount should also be able to fold and tuck under the armrest.

While the client concerns can be addressed relatively easily, they will not have a large effect on the project until the third prototype when it comes time to install the mechanism on the wheelchair. As such the design and testing plan for prototype two remains relatively the same following the third client meeting.

3. PREVIOUS PROTOTYPES

Since the scope of our project has changed, this will be the first prototype.

4. ANALYSIS

The focus for this prototype is to analyze the conceptualized electronic circuit.

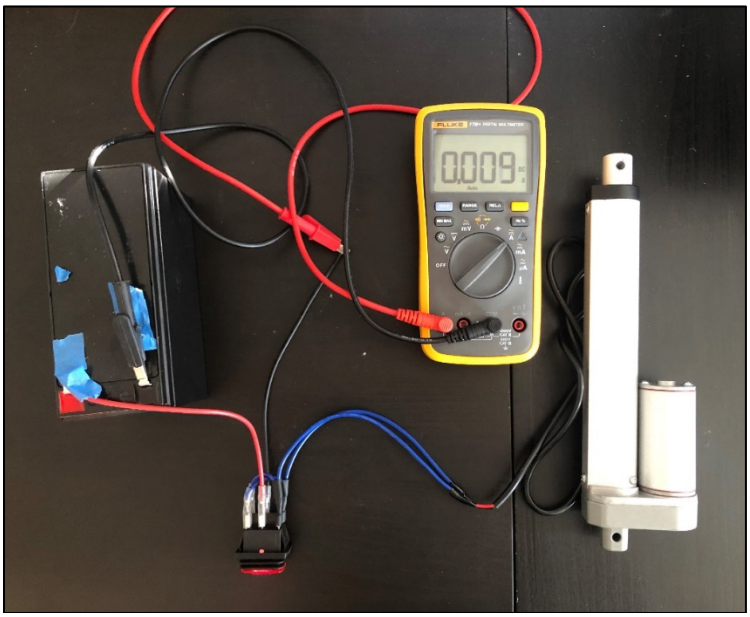

Figure 1: Electrical Circuit Without Load

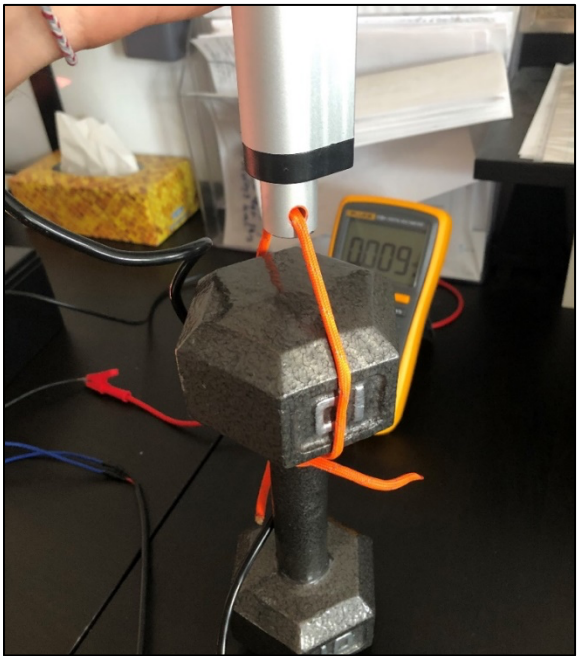

Figure 2: Linear Actuator with 10 lb Load Attached

To accurately test how the actuator would behave under the estimated load of the pedals, a 10lb weight was secured to the actuator with rope. The results found are displayed in table 2.

4.1 Why? (Prototype test objective)

The main goal of this prototype is to communicate and show the client a visual demonstration of how the electronic system of the pedal lift will work. The prototype's results and feedback will determine how the group will adjust/customize the wiring to better improve the final product.

4.2 What? (What have we done so far and how we're testing it)

The prototype used in this test is a wiring schematic of the final product. The prototype needs to have the basic requirements that the team identified in the previous deliverable. The prototype will use the linear actuator, the wires, and the battery used to build the final product.

4.3 How? (Test results and what we have learned)

- Confirm all electronic components such as the linear actuator, the switch, and the battery all work together.

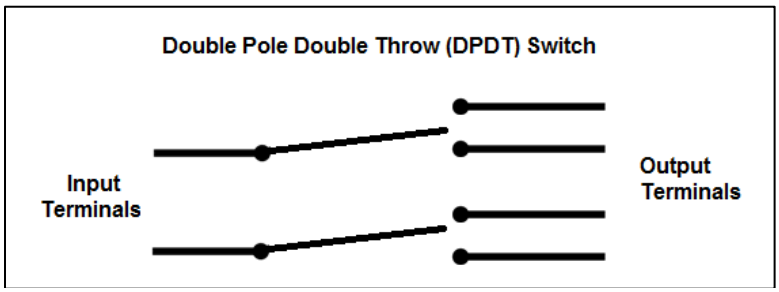

Figure 3: Double pole double throw (DPDT) switch

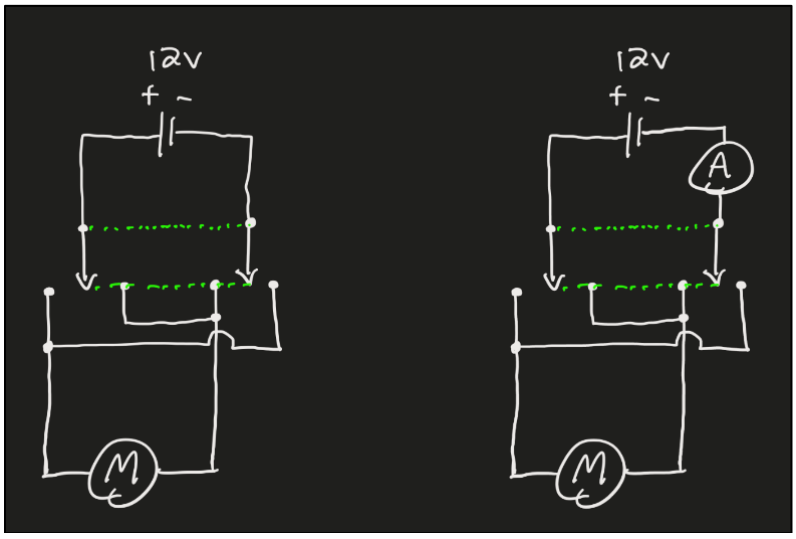

Figure 44: Circuit diagram with and without ammeter

*Note: The green dotted lines indicate a mechanical connection; the switches will always switch synchronously. When a switch orientation is changed it inverts the direction of current.

- Measure the speed of the actuator, and act accordingly. If the actuator is too fast, use a microcontroller to control the speed.
    - Upon testing, the actuator's speed was 0.97 mm/s which is reasonable for lifting the pedals slowly, without breaking anything or causing any sort of injury to anyone in the vicinity of the wheelchair. Since the speed is slow there is no need to include a microcontroller into our design.

- Measure the amperage draw, and act accordingly. The amperage was decreasing with every run, which might indicate that the battery is dying, or that the lubricant within the linear actuator is spreading around and reducing friction within its mechanism.
    - The voltage of the battery was still at its rated voltage, indicating that its battery life was not dropping.

Table 1: Testing Results

	Load Applied (10 lb)	**Without load**
Travel Time (s)	20 down; 16 up	15.5 both ways
Distance (mm)	15	15
Current Draw (mA)	1100-760	770
Speed (mm/s)	0.75	0.97

*Results collected with the linear actuator in a vertical orientation under a load of 10lb.

This test determined that all the components work together as intended. The multimeter found 770mA was drawn while the actuator was in motion as seen in figure 1. When a load of 10lb was applied to the actuator a current draw of 1.1A was initially found, then reduced to 760mA once the actuator was in motion. The 10lb load was chosen because it represents roughly the mass as both foot pedals. The travel time was estimated using a stopwatch.

As seen in figure 1 the button draws a constant 9mA due to the led. This current draw is very low and should not cause too much drain on the battery.

5. UPDATED 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 2:Update Bill of Materials

Material	Place	Cost per unit	Number of units	Total cost (CAD)
Linear Actuator	Amazon	$67.39	1	$67.39
3 Pin Button Switch	Amazon	$16.99	1	$16.99
12V-7Ah Battery	MakerLab	$1.00	1	$1.00
3D Printer Filament	MakerSpace	$0.00	0	$0.00
22awg Electric Wire (5ft)	MakerLab	$2.50	2	$5.00
Lead-Free Solder Wire (4oz)	Patrick's Place	$0.00	1	$0.00
Scrap Acrylic	MakerSpace	$0.00	2	$0.00
Bolts	Canadian Tire	$2.29	1	$2.29
Nuts	Canadian Tire	$0.17	3	$0.51
Rubber Mats	Amazon	$8.72	1	$8.72
Zip Ties	Patrick's Place	$0.00	4	$0.00
*Tax not included in price **Product links in the references section			**NET COST:**	**$101.90**

6. PROJECT PLAN

This section contains the status of Wrike. Following prototype two, the next large focus for the project will be deliverable F which discusses the second prototype along with the feedback collected from the third client meeting. Following deliverable F, the group will spend time creating the business and economics side of the project.

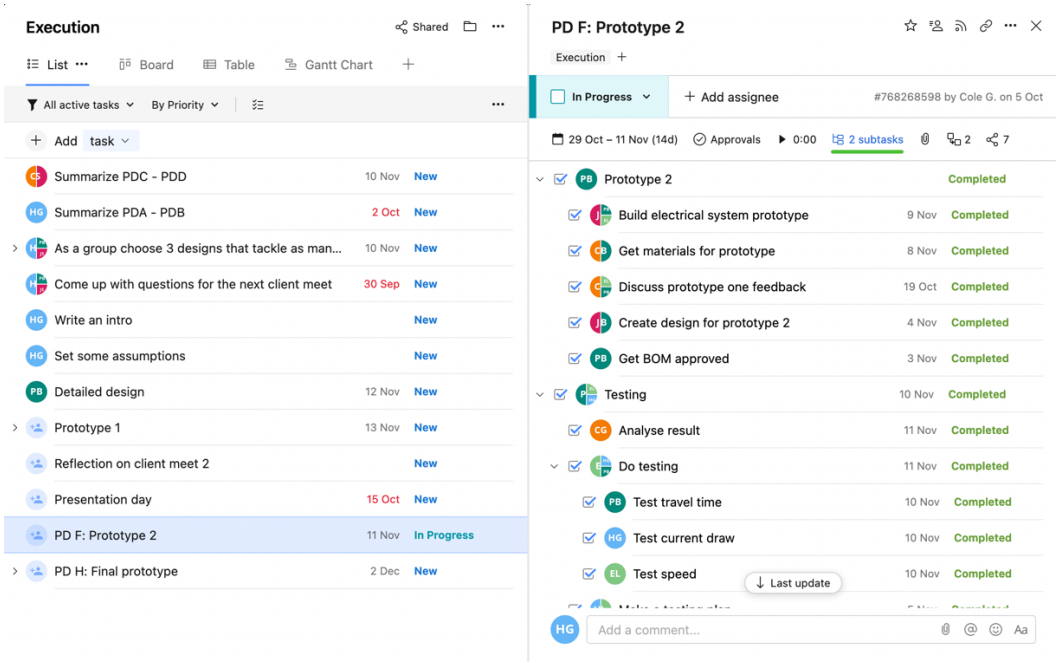

Figure 5: Wrike screenshot 1

The figure above, *Figure 5*, shows our execution folder from Wrike. The part to the right shows a maximized view of our project deliverable, *PDF: Prototype 2*. For this project deliverable, the group divided the tasks at hand into 4 phases: Prototype 2, Testing, and Drafting the deliverable document. These subdivisions into "smaller" tasks help the group stay on track by knowing what should be done. Following this methodology, the group was able to finish this deliverable on time, while not leaving any detail unaccounted for.

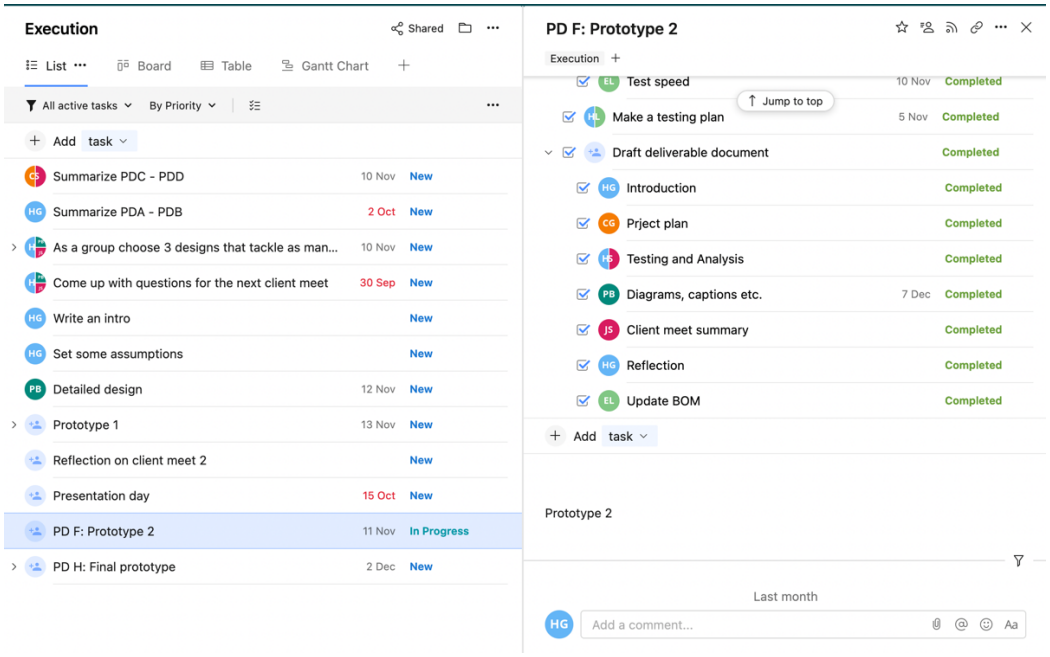

Figure 6: Wrike screenshot 2

The figure above, *Figure 6*, shows the rest of the tasks the team had, since the tasks did not fit in one screenshot.

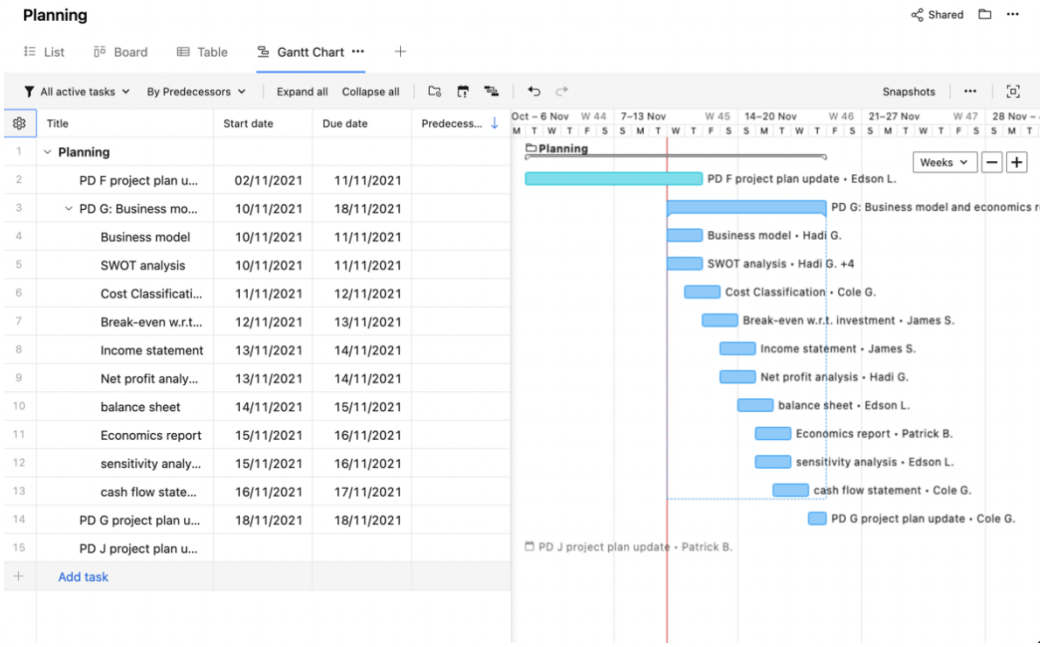

Figure 7: Wrike screenshot 3

The figure above, Figure 7, shows a Gantt chart view of our progress for *PDF: Prototype 2*.

7. REFLECTION

In conclusion, the team has created a prototype that was designed in the previous deliverables. This prototype has undergone testing to test its functionality as well as its user experience. The team has discovered that although the prototype shows promising results, multiple of issues have been discovered. A test plan has been developed in the deliverable to analyze the method as well as the results.

As part of the testing and analysis the team collected feedback from potential users. This feedback will be analyzed during the next deliverable and during the improvement of the prototype. The team also had to update the Wrike following the modifications that user made during this deliverable. The next step is to thoroughly analyze the feedback, apply it to the improvement of the prototype and finally collect feedback from potential users once again with the improved prototype.

8. 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].

Bill of Materials links:

Linear Actuator:
https://www.amazon.ca/gp/product/B07TKXQ5H1/ref=ppx_yo_dt_b_asin_title_o00_s00?ie=UTF8&psc=1

3 Pin Button Switch:
https://www.amazon.ca/Twidec-Momentary-Miniature-Waterproof-MTS-123-MZ/dp/B07VR93FS1/ref=mp_s_a_1_17?keywords=3+pin+switch&sr=8-17

12V-7Ah Battery:
https://edu-makerlab2021.odoo.com/shop/product/battery-90#attr=158

22awg Electric Wire (5ft):
https://edu-makerlab2021.odoo.com/shop/product/wire-5ft-45?category=9#attr=213,217

Lead-Free Solder Wire (4oz):
https://www.canadiantire.ca/en/pdp/aim-aquasol-lead-free-solid-wire-solder-0586001p.html#srp

Bolts:
https://www.canadiantire.ca/en/pdp/hillman-grade-5-hex-cap-screws-assorted-1617963p.html#srp

Nuts:
https://www.canadiantire.ca/en/pdp/hillman-hot-dipped-galvanized-hex-nuts-1610448p.html#srp

Rubber Mats:
https://www.amazon.ca/NEOPRENE-protection-isolation-required-supports/dp/B08LQYLPXV/ref=sr_1_4?keywords=rubber+sheet&s=hi&sr=1-4