ESI3001: Student Internship Programme

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Supervisor: Wong Yuk Rung

Abstract

My Student Internship is about Braiding Thermo-Plastic Samples for SGH and the supporting Educational Institute, Temasek Polytechnic. The first half would be the initial, and the after, is prototyping the Bio-Mechanical Thumb for an amputee.

1. INTRODUCTION

1.1. Background

I was first, introduced to PCL, a Thermo-Plastic Material, that was used to braid. Mr Tan Kim Cheng, offered to demonstrate how to braid and we agreed with my Supervisor, Mr Wong Yoke Rung on the recommended length. We had subsequent meetings over the internet, since I was situated in Temasek Poly the entirety of my SIP, due to the CoVID 19 Situation. The deliverables I agreed on was to deliver 300 of Braided Samples, unofficially, as well as develop the Bio-Mechanics Thumb with whatever remaining time I have.

1.2. Objectives

The project's objective was to learn about Braiding by cutting 12 strands of PCL Filament of length 200mm to 250mm and twine both ends with molten PCL. Three bundles of 12 strands are needed so that the length is 25mm maximum.

The specific objectives were to:

- Research and read up the relevant topics about Pizo-Electric Mechanics and relevant programming to drive it.
- Discover and Explore Structured C++ Text Programming online using Google.
- Come to Lab for training on Braiding and Designing the Thumb.
- Disassembly and Reassembly of the aided printable structures, Dispenser, Maypole Braider, etc. to enable easier execution of Braiding Samples.
- Equip the Lab with required Bacterial, Alcohol Substances, Gloves and Stainless Steel to prevent Cross-Contamination.
- Enable Communication between Mr Wong and Mr Tan.
- Differentiate between the Deliverables and the Bio-Mechanical Thumb.
- Program C++ Code in Arduino to learn fundamentally, how Micro-Controller, connects with various modular Mechanical / Electrical Devices.
- Investigate the differences of improvements made to the braid to withstand a sustainable Pull Force and allow additional biological seeding.
- Sequence the resupply of Material, so that more Braids could be made.
- Enhance on my aided Mechanical Printables, including the Bio-Mechanical Hand.
- **Program the Arduino Board if funds are available for Sourced Materials despite push for it in the early stages.**
- Combine the program to produce a line of functioning mechanisms.
- Verify if the mechanism works.
- Program, Design and Visualize the Bio-Mechanics Hand and Printables.

The process of the project runs though Research, Plan, Training, Self-Learning and Practice. These steps are needed to transition between Braiding and the Bio-Mechaniccal Thumb.

2. PROJECT DESCRIPTION

2.1 Braiding Technical Specifications

It takes just 3 bundles to braid. Ten Strands was initially bargained for, but we settled for a more giving number of 12. Adding a state of an additional two, allows for the braid to withstand a greater pull force in their attempts to test it's resilience. Mr Wong, officially, known as the leading head research officer, thought it would be fitting to take his ride and accomplice over. They measured the intricates of the bundle so that I would be able to stick close to his ideal standards of an acceptable grade. Otherwise, just known as acceptable, I would assume, more would have to be made to attain for the samples size and failure rate. Support Structures, I suggested were introduced, which were the Dispenser and additional protective equipment. I used extensive amounts of clean alcohol and bacteria wipes to prevent cross contamination. Despite all the efforts made, an unofficial, less formal agreement was made for 300. For obvious reason, more was always better and one should always try his/her luck.

2.1.1. Taking Braiding to New Heights

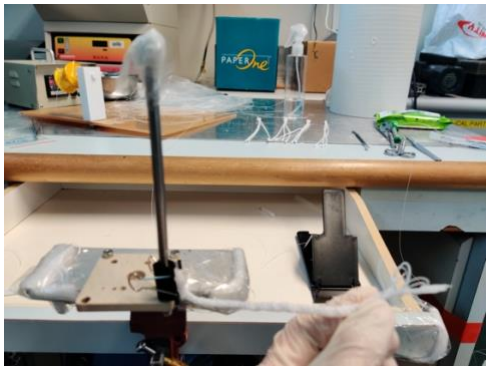


Figure 1: Setup

Figure 2: The RIG

Description

The Station you see above is what you call a good use of Manpower. The Braids generated will later be seen along in this Report. My Friendly Lecturer had created the environment with the extruder (see Fig. 2). This is the Main Station, where all the magic happens. I do spend a lot of my time making the 300, which I must emphasize, is a lot from a humble setup. Additional efforts were made to ensure that more braids could be produced later. However, in this Section, I would like to point your attention to Figure 1. It labours the 3 Strands which are clipped in a bundle. This will further be sectioned into 25mm Braids, by fusing the end points.

2.1.2. Squeeze Strands?

Figure 3: Main Extruder

Description

You have to know that the appeal is not always everything. This lovely reliable extruder squeezes out the white PCL Material with a diameter of only 3mm. It’s so hot, that it needs a blower fan to make sure it’s Motors and Hopper remain at a nice warm temperature of a 100 Degrees. I know, from the look of it, it looks dark. Rest assured, it’s bright enough in person.

2.1.3. The produce

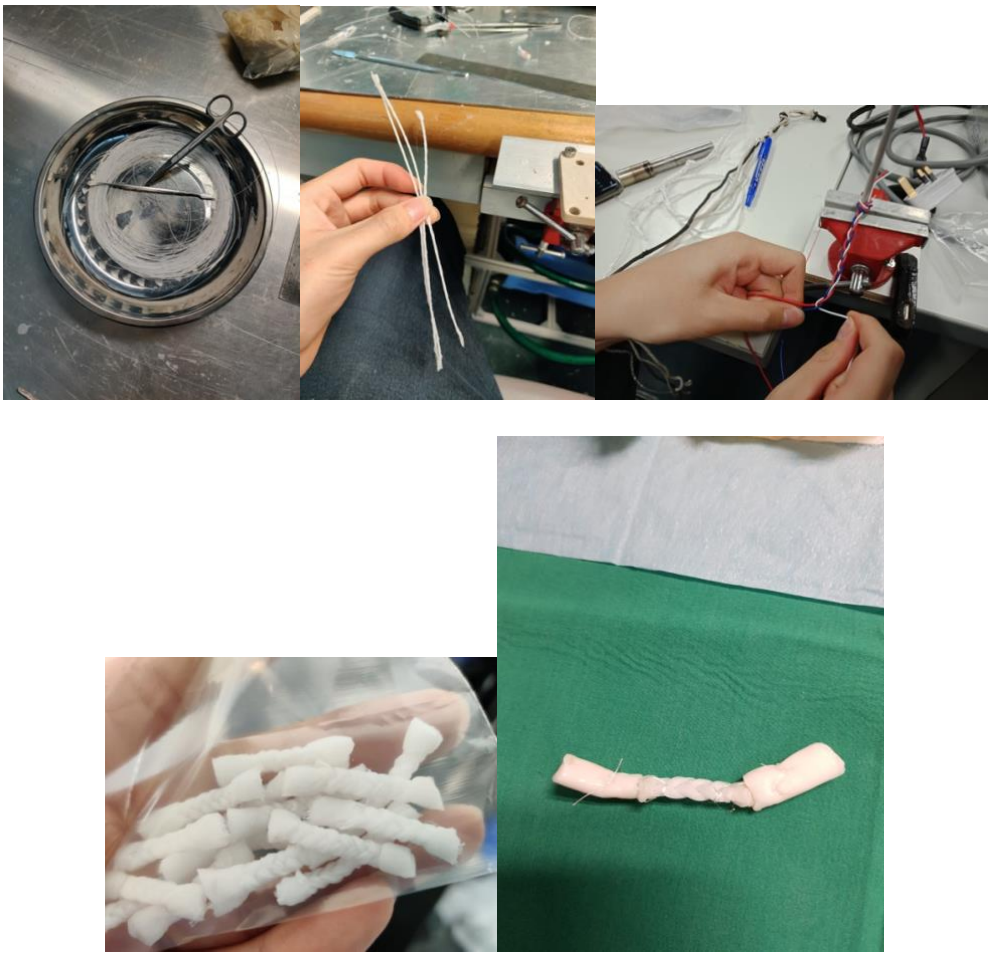


Figure 4: The Braids Themselves

Description

It is pretty fitting to say that they're the best fit. They are tight and have roughly a pull strength of 29N. They are meant for rehabilitation of the torn tendent/joint. They are otherwise, known as Tender. I don't suppose we need it to be strong enough for the regrowth and maturity of the cells. This is to support Post Recovery and the Outpatient Clinic.

2.1.4. How do we keep it Non-Wet Dry

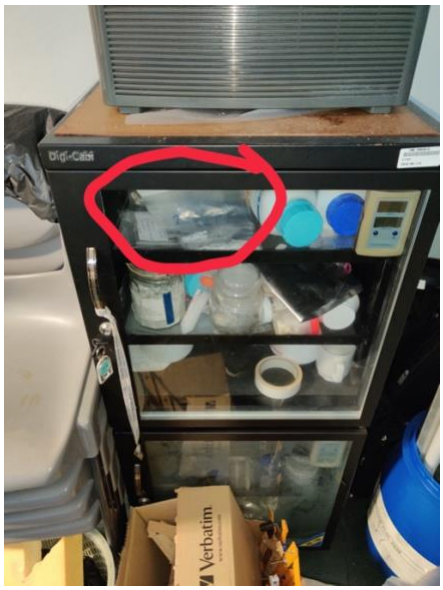


Figure 5: Dry Box

Description

It’s not a precision device, but it will do the trick of keeping it safe and dry. I know it’s just a box, but the contents are probably worth more than your life. But the point is, that the Leading Research W. can take some of that Hard Labour ex. Braids (see Fig 5). The red circle puts further emphasize, so take a closer look before it’s too late. Now, at the point of writing this, it might be still there. By the time, you see this, it’s gone. The moisture has to be kept at a minimum to prevent unnecessary contamination, I know.

2.1.5. The Location

Figure 6: Location

Description

If you'd like the address, here it is. You can always take it out on the ones you feel are vulnerable. Just remember, thought and preparation has been put to plan. Only to know that, it is a transparent Educational and Medical Institute. If you'd like to make out a few advance exploits, it might be targeting the very person you'd intent. Remember, it's real lives on the line.

2.2 Process Description

2.2.1. I/We do 10 at a time but package 20

The cheek of the ones that dares to ask for 20, will get 20, with 10 a day.

2.2.2. Main Program

The packaging and braiding contents will be further sold at the extent of the student. Free of charge. It will be in the lower part of the Report. Lower part, means, more reading to do. Get with the program.

2.2.3. Test and Evaluate

I have two Wise Man to approve everything. As well as some Material Engineering and Racial Linguistics, we have made it! The Braids do get some extensive eyes on it. As well as Process Description and Proposal. Seems like you'd always be in on the ACTION.

2.2.4. Visualize the Outputs

The braids are pretty aesthetically pleasing, I must say. They are the direct output, although not the principle activity of both the institutes. They are a visual spectacle to be mesmerized, although I do find it attractive in women.

3 PROJECT DEVELOPMENT

3.1 Stages of Development

3.1.1. The Big Rollers (Dispenser)

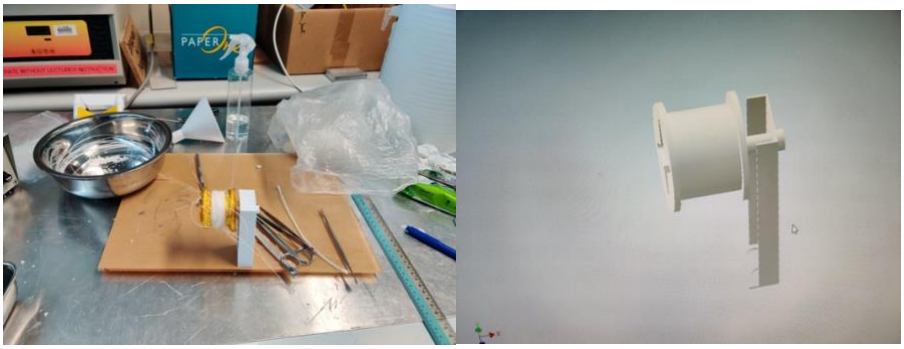


Figure 7: The Dispenser makes it Faster

Figure 8: Jigs that look like Test Kits

Figure 9: Packaging

Dispenser

Figure 7 is the dispenser that makes dispensing much easier. It could get tangled up like hair making it impossible to separate. The Jig is used to Coil and Cut the Braids so that they can be fused at the ends. This sped up the process by 300 folds (see Fig. 9). The Yellow Tape is just used extensively to remove the exposure of the PLA Material with the PCL Material. The Stainless-Steel Material, Bowls and Tools were used in the presence of the PCL to prevent cross contamination (see Fig. 7).

More will be elaborated in the Results Section

Packaging

The packaging was always used to bag the braids in all purpose, so that they can be passed over to Researcher W._.

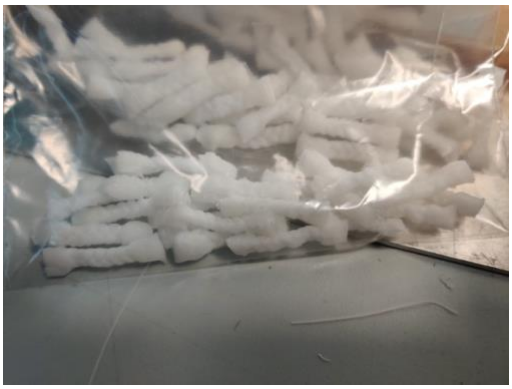
Bite Size Failures

I had to retouch the Braids right after some of the Design Process and found I could make it tighter, with more practice. It became quite apparent that W. wanted more to be made. Obviously, the other half of the SIP was totally, ignored.

Comparision

BEFORE

AFTER



3.1.2. Use of Alcohol / Medical Grade API's, Gloves & Surgical Tools

Figure 10: Hand Sanitiser & Spray & Gloves

Figure 11: Surgical Tools

API's in a Bottle

Medical Grade API's, Alcohol and Bacteria Sprays, are used regularly before/during/after every Brading Session to ensure that contamination are reduced to a minimum (see Figure 10). The API are considered consumer goods and being delivered in a 5L Container. It will be dispensed, further, into the spray bottles you see above.

More will be elaborated in the Results Section

Gloves

Gloves were also used when making physical contact with the braids. They were a standard issue passed to me by W. After producing the 100 samples, he decided to supply more gloves to produce the next 60. On the seconds meetup, a box of gloved were issued to produce the final 140.

Transferrable Inventory (3.1)

The transfer of Braids into the Bag needed to be handled with care using Surgical Tweezers see (Figure 11).

Handling

Gloves were the main Priority of Handling. **Surgical Scissors** and **Blades** were also used to cut and fuse. The PCL material was also coiled around the barrel wrapped with **Yellow Heat Tape**. This should separate the contact between PCL and PLA. **In times like this, extra care and hygiene standards were kept. SafeEntry Logins and Masks were worn during the period of Braiding.**

Bite Size Failures

Initial attempts at braiding the gloves made the braids looser since the gloves had a layer coating. The application of the Hand Sanitiser (API) with moisturiser (glycerol), on the gloves, made it easier to braid it tighter.

3.1.3. Maypole Braider

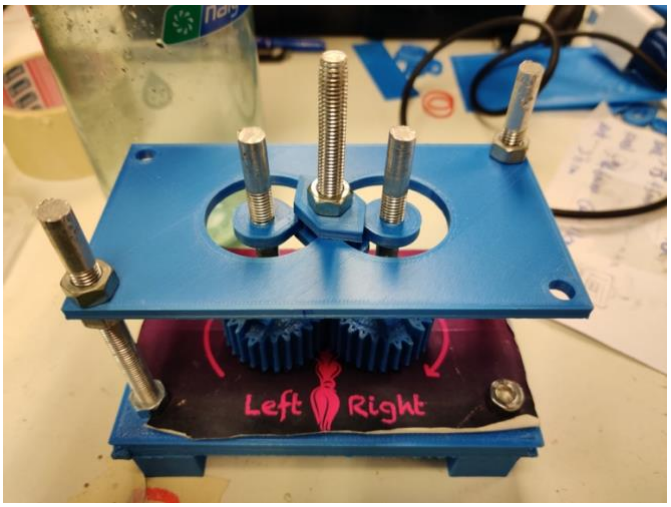


Figure 12: Maypole Braider Assembly

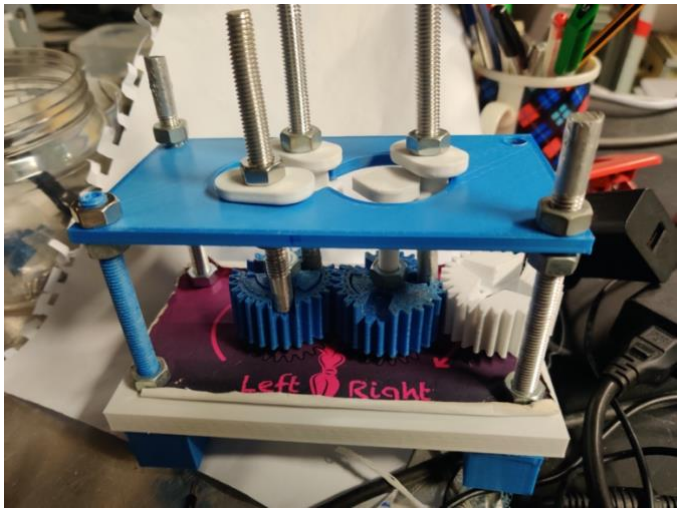


Figure 13: Modifications

Maypole Braider

The MayPole Braider was initially proposed to Mr Tan in an attempt to create a proof of concept prototype to braid the scaffolds through, Automation (see Figure 12). This aided Design and Mechanism shows the potential for the braids to be done through a Drive Motor / Rotary Motion (see Figure 13). The Braider will be shown later in action.

More will be elaborated in the Results Section

3.1.4. Hopper PCL Dispenser & Funnel API

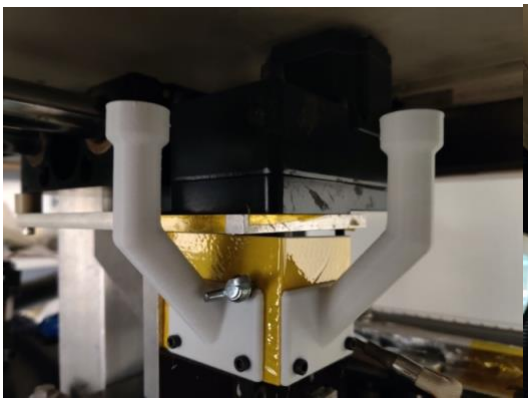


Figure 14: Tubes Delivery

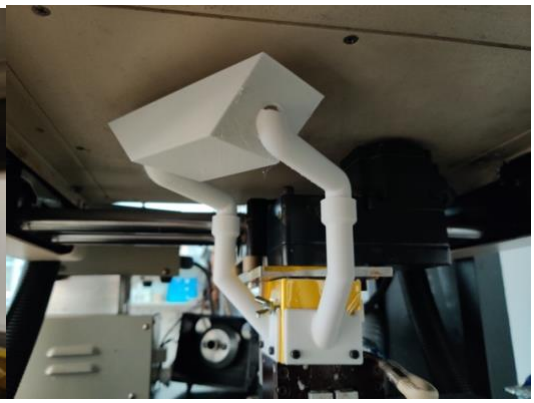


Figure 15: Hopper Dispenser

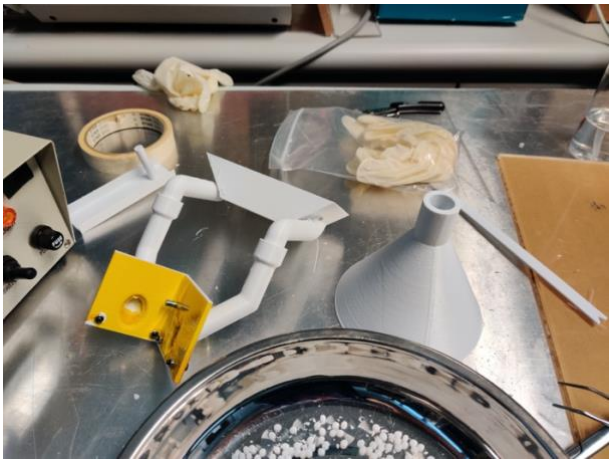


Figure 16: Hopper Dispenser & Funnel API

Dispenser & Funnel

The thought of creating a dispenser for the Main Extruder was being passed, since the regular Top Ups, were being done using a spoon. The PCL Powder will fill the Hopper and it will be distributed into the tubes. This could be used as an easier alternative to fill the excess. The Main Frame is designed to be mounted on the main one with one screw. It acts as an extension / top down dispenser. The exclusiveness of the Funnel allows the clean API's to flow into the spray bottles with accurate precision.

More will be elaborated in the Results Section

Installation

The Main Frame had to be wrapped with Yellow Heat Tape to prevent the Aided 3d Printed Material (PLA) to contaminate and melt away since it was heat sensitive in all areas. Stainless Steel was used on the Main Extruder. Since, it was a working prototype and proof of concept, I had only a choice of wrapping it up before the day on Christmas. It would be considered a celebratory gift of exception.

Drop Height

The Drop Height and delivery of the PCL, through the tubes, is important. The position of the opening had to be above so that the PCL fills the Primary Hopper.

Funnel Splash

The effect of Alcohol Splashing all over you would seem messy and could sting a little. I was fortunate to allow the opening long enough for the liquid to fall into the spray bottle. It actually seems fitting for that spray bottle. It’s a fact.

Bite Size Failures

There is a height constraint within the Main Housing of the Extruder. The Frame, Dispenser and Tubes had to be designed in order for it to fit sufficiently. However, it would be difficult to feed the PCL into Hopper, regarding the height.

3.1.5. Printer Maintenance

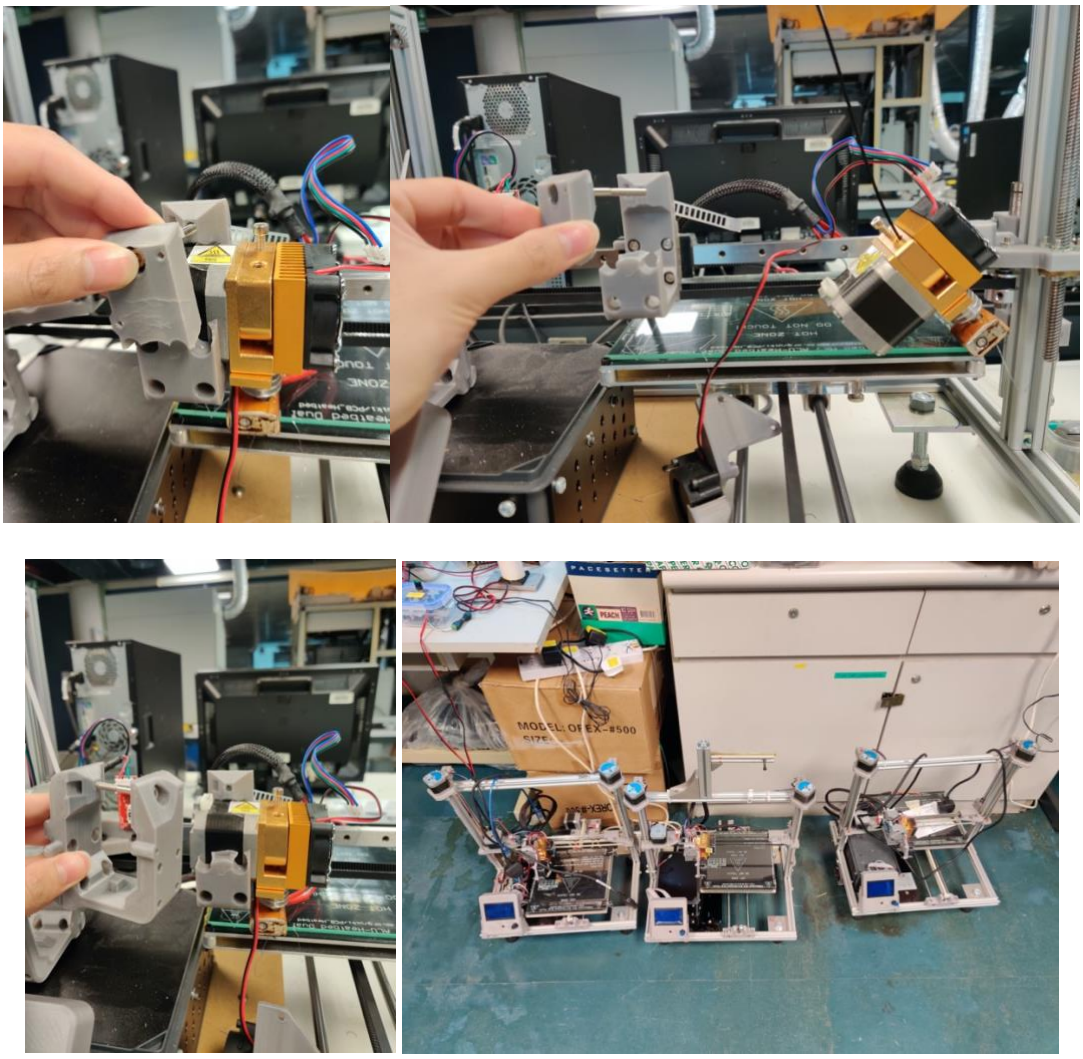


Figure 17: Printer Fault Maintenance

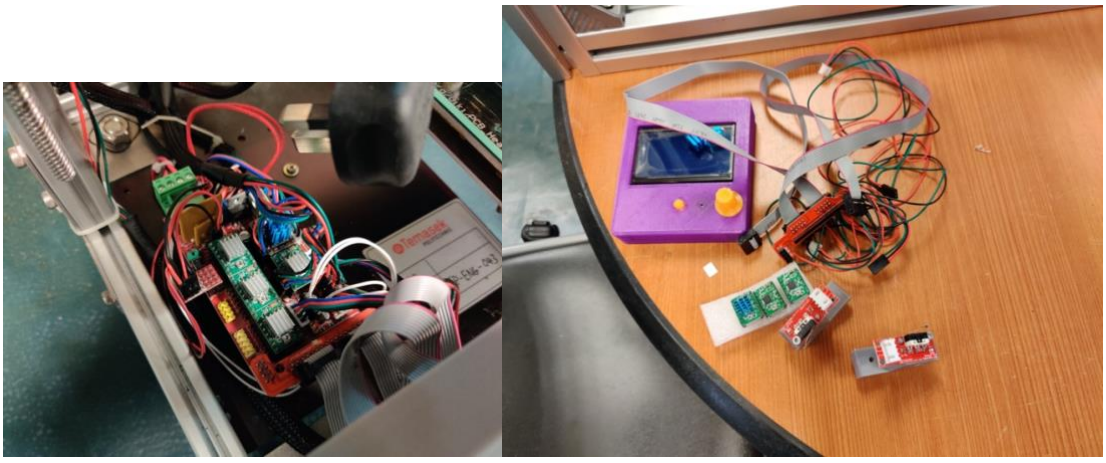


Figure 18: Printer Electric Motor Driver Fault

Maintenance

The Array of Printers in the Lab has suffered a major downturn and have seen better days, since the CoVID Breakout. The faults range from broken supports, burned drivers, non-heating beds to inaccurate printing. The priority was to get one or two, back up and running for the new batch of students. The usage will likely be frequent, so priority was given to servicing it.

Mechanical Alignment

Mechanical Alignment of the bed was necessary to ensure the surface finishing was not compromised. Inaccurate Alignment could also cause the print to shift and fail since there could be too much abrasion between the nozzle and the print. The 3 screws underneath the bed is used to adjust the bed height, relative to the Z-Axis.

FIRMWARE Repetier Host

Repetier Host is used as the Main Slicer to turn CAD Files, mainly .STL, into a coordinate system down commands. The printer can read and execute it using it's built in Firmware from Repetier. The Firmware is being Flashed onto a Main Arduino Board with RAMPS. The assigned technician (Mr P.) does this as a second version to TP's Array of Printers.

G-Codes

G-Codes are relatively common to issue a state to a printer. Efforts were made to scale the printer, keeping the relative nature of it intact. Previous batched attempts were being followed by the next batch.

3.1.6. Bio-Mechanics Thumb

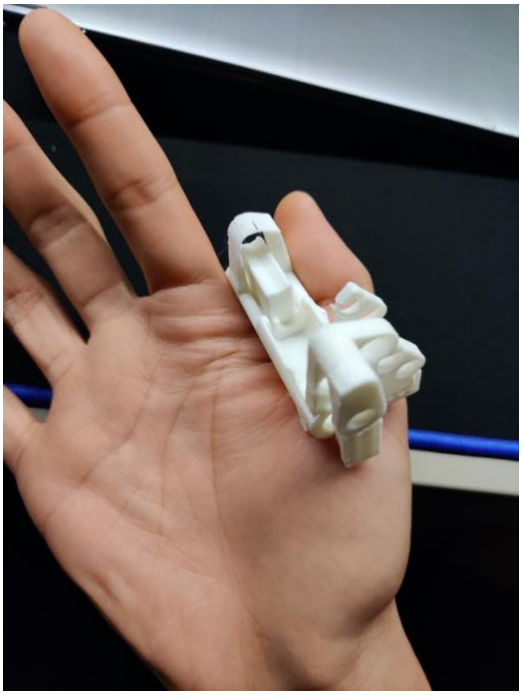


Figure 19: Main Frame

BioMechanics Thumb

The initiation by SGH and Temasek Polytechnic in a joint venture to produce a working protype substitution of a thumb was valiant in it's efforts. I was assigned on the project in the second-half of the Semester while I was still producing enough Samples for 300. Majority of the Project was followed up by the Major Year Project Team. The whole section of the Design, Mechanical and Source will be further elaborated in the results section. The housing should be sufficient to house the required mechanical components and motor. This allows for increased degree of freedom to replicate the movement of the Thumb around an axis. Additional pulley systems are needed to aid the grip of the Thumb.

4. Results

4.1 Braids

4.2.1. Introduction

Figure 20: Introduction

Introduction

The initial Introduction Phase when I was first enlisted into SIP, was about getting confirmation of the requirable length. Setup and attempt were made for an allowable tensile strength at that moment of time. In the moment of it all, the Braids slowly became what will be a journey. I will take you down memory lane as we pass through the Introduction Stage.

4.1.2 Making it **Better**

Figure 21: 1st 100 Batch

1st Batch

The good Produce of a 100 might get me in some meth trouble with the law. Grams, that is. But this good Braids might give a man back his Leg. Numerical 100 of Braids was my first produce. I wasn't Quality I am proud of. But I will keep making it better. It was wrapped in a plastic bag, ready for a deal with W. We met up and exchanged the goods and services. It might not look like a lot, but you'll know it when you see what happen after. I must say my product does make the world go around. What a small world it is.

4.1.3 Handling and Sorting of 20 to 300.

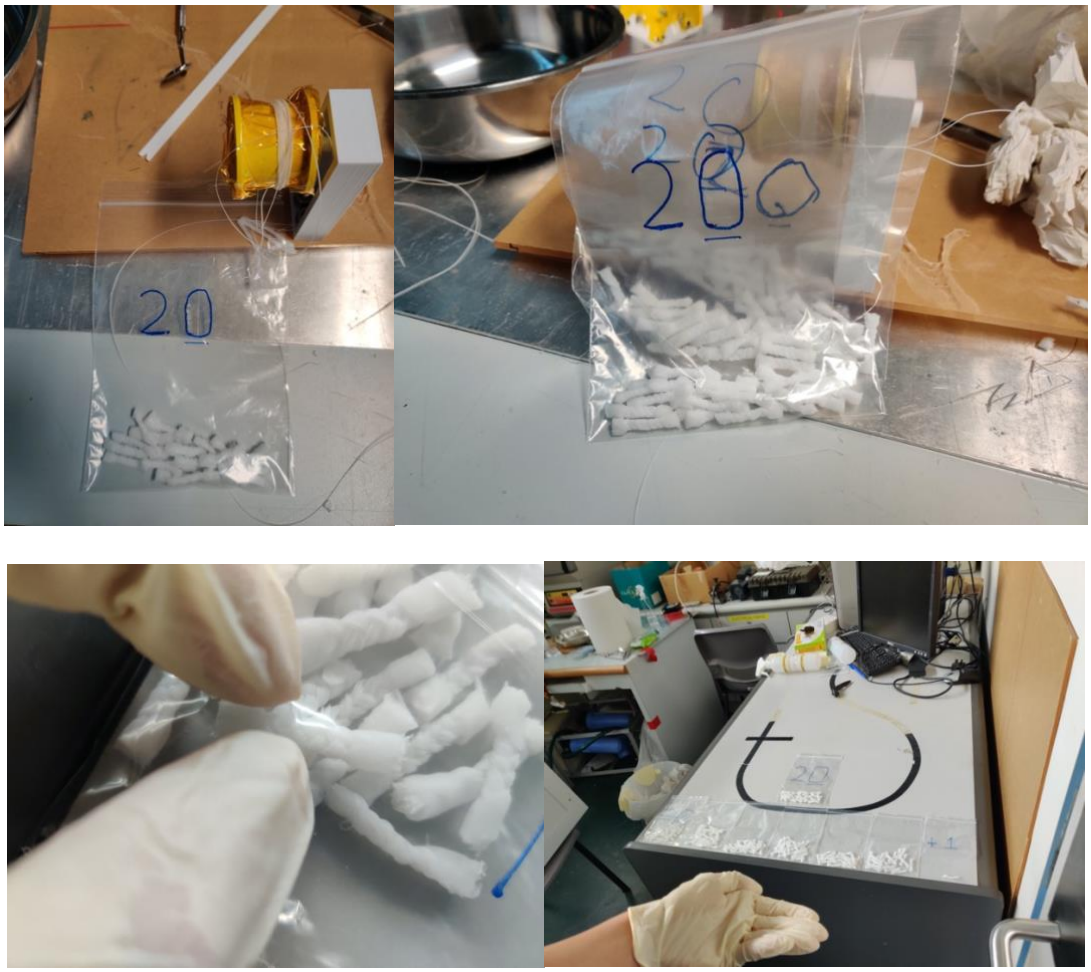


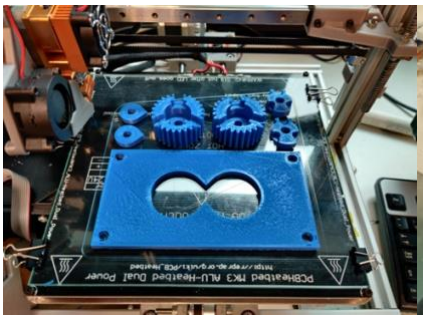
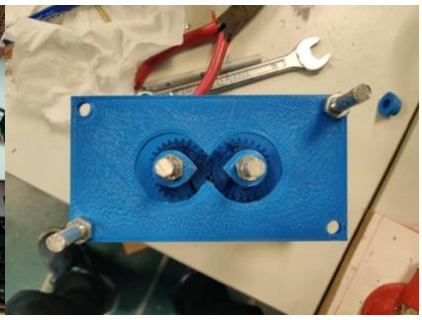
Figure 22: Handling and Sorting Station

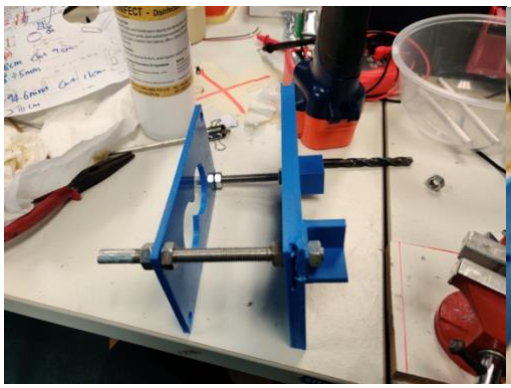
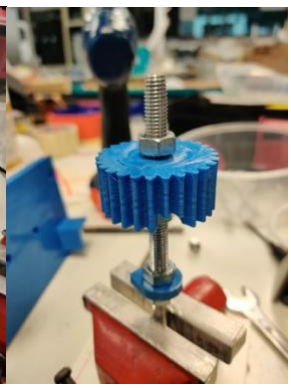
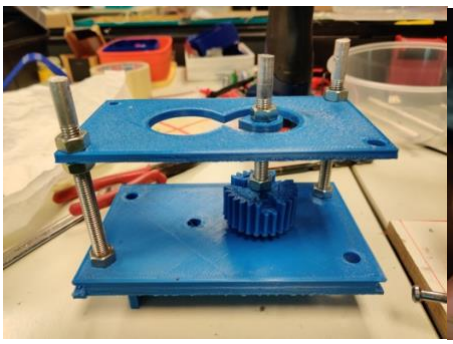
Handling

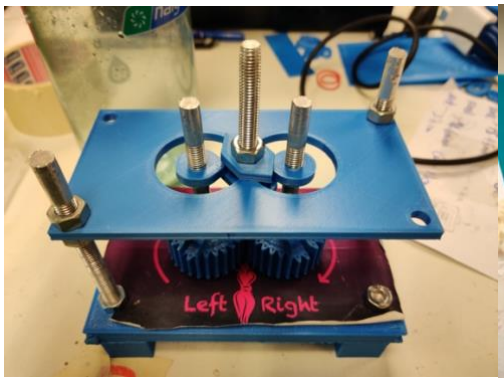
If you aren't convinced of 10. It's 20 enough? It is more than ready when this hits the lot. When you've prepared, take a closer look at the sample size and quality. I must say, time has really gotten to it. The packaging like I said earlier is made much cleaner through the necessary steps it is required to ensure: **In times like this, extra care and hygiene standards were kept. SafeEntry Logins and Masks were worn during the period of Braiding.**

EMAIL Submission Proof of 300 BRAIDS	300 EMAIL (.EML): https://drive.google.com/file/d/1MX_1clo5yVTLQFFg43rkzxlj6d0HUP9e/view?usp=sharing
Video Progress	I will provide the video with the progress I made through visual representation. **LIVE** Braiding: https://youtu.be/kN385rnxcEI Video FINAL 140: https://drive.google.com/file/d/1uPNzXgMz11JEu9wsOgPdgqz1eVAdenMW/view?usp=sharing

4.1.4 The **Finer Things in Life**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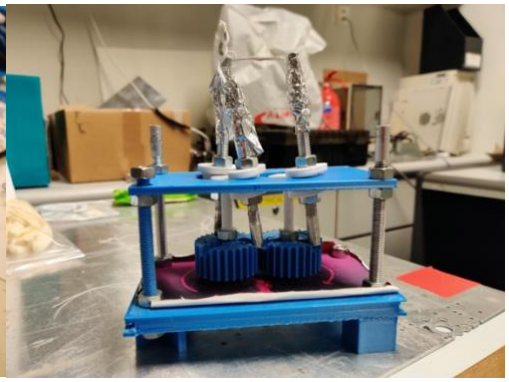
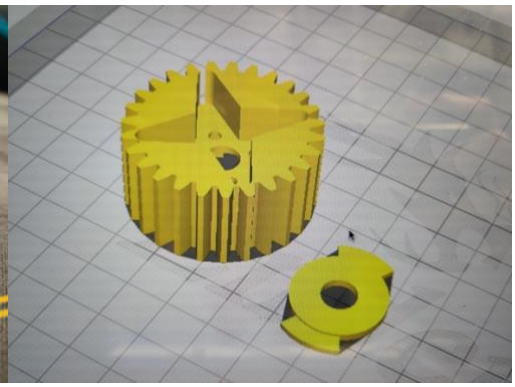
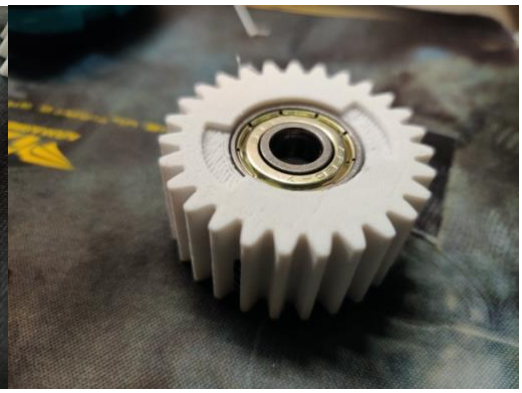
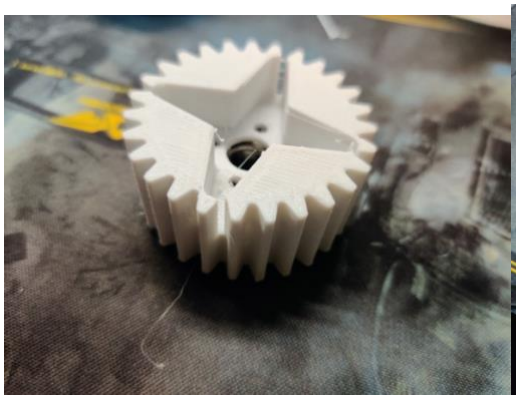
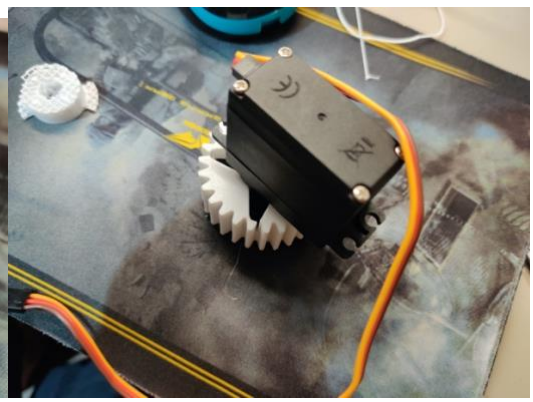










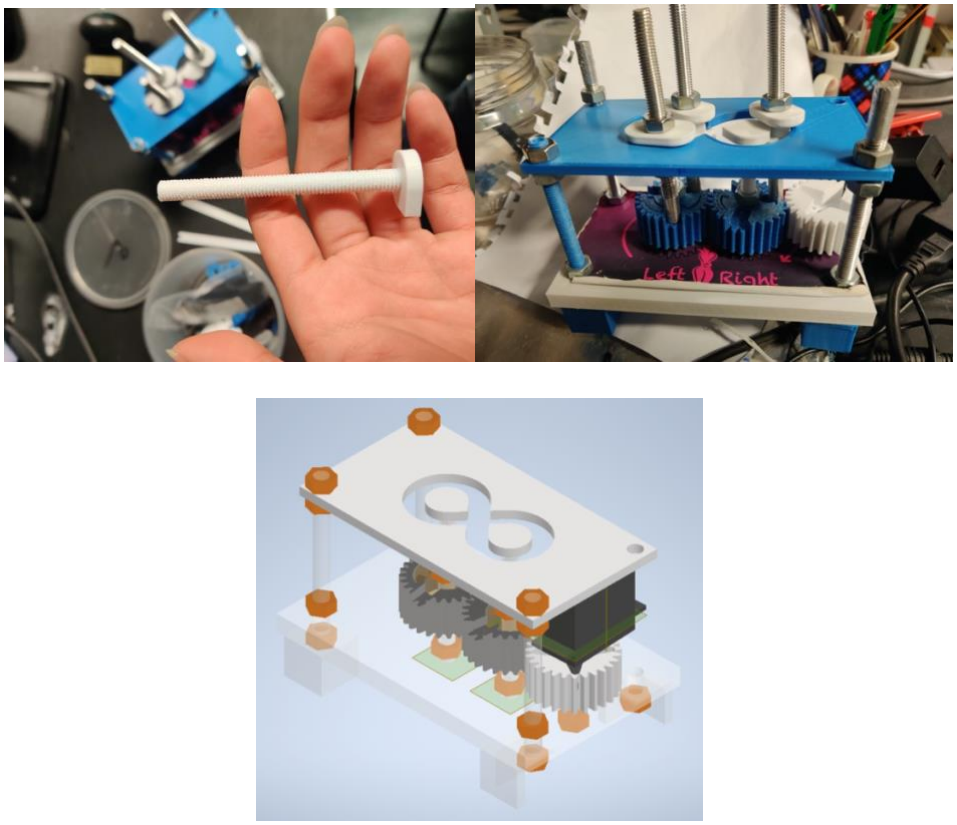


Figure 23: Maypole Braider

Maypole Braider

The Maypole Braider (Figure 23) was elaborated before. Now, you get to see the development stages it went through to achieve what Braids. What now? Well, it isn't that Simple. You still got to use your hands if you want to make it. Off course, this proof of concept is ideal only in the realms. Behold the showcase through the Pictures and Videos. The videos will be linked below.

Video Progress

I will provide the video with the progress I made through visual representation. The videos will all be linked to YouTube.

Maypole Braider Video: https://youtu.be/0WypOn-wAMw

Maypole Brading STEPS: https://youtu.be/BbmbgiIHDjI

4.1.5 Hopper in **3D**

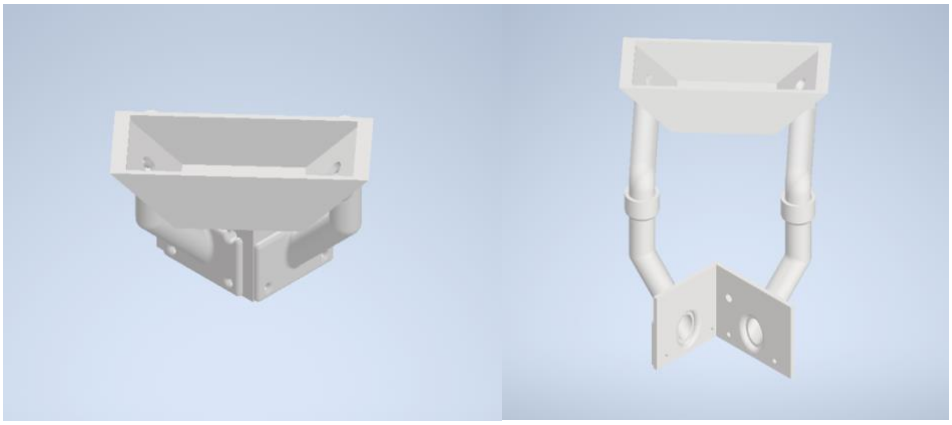


Figure 24: Hopper 3D

3D

If you really need to see the Hopper in 3D (see Figure 24). I am more than Happy to show it through my Eyes. It shouldn't be too hard to take in the spectacle. It's a wonder that sets the cast to take on the action of dispensary. The PCL will fill the primary with honour.

4.1.6 “Cleaner Than Relationships” **BOX**

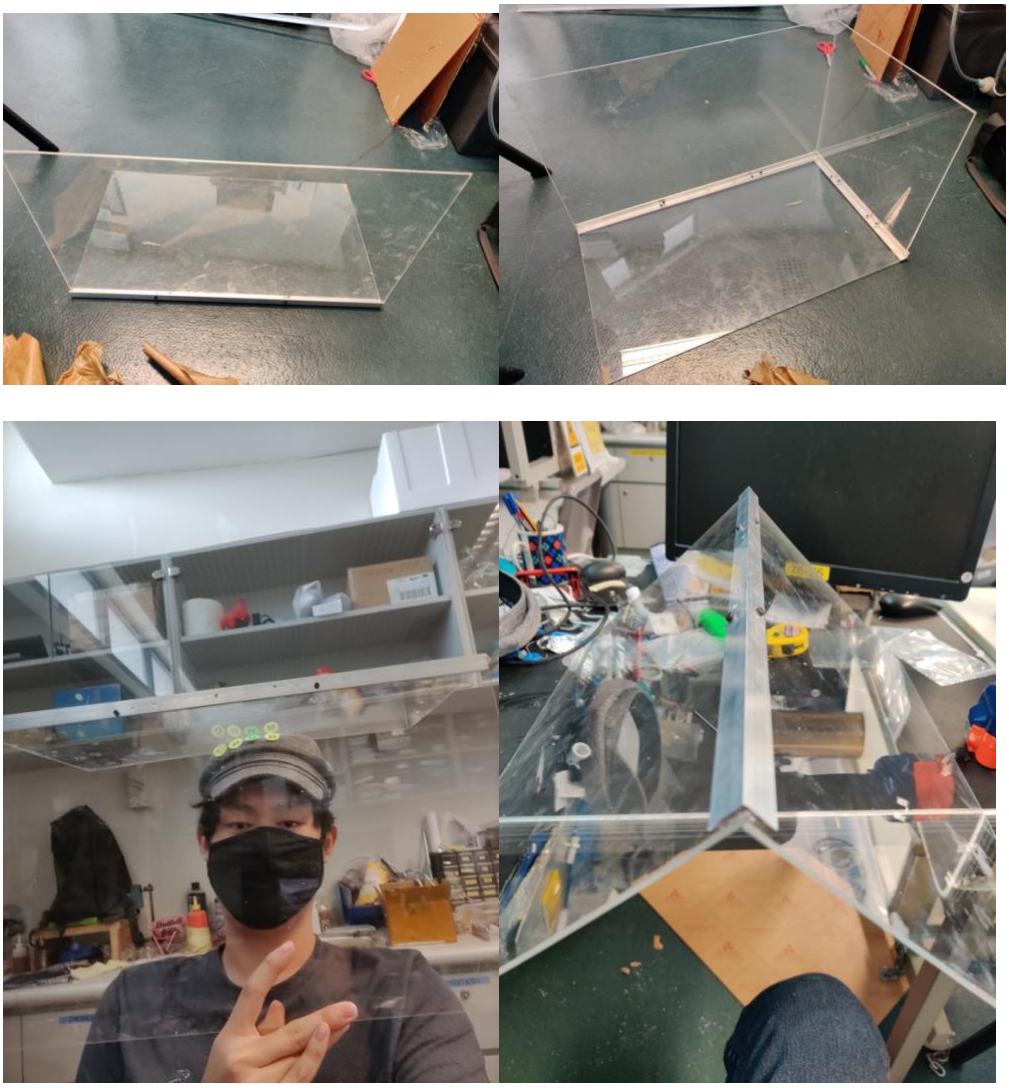


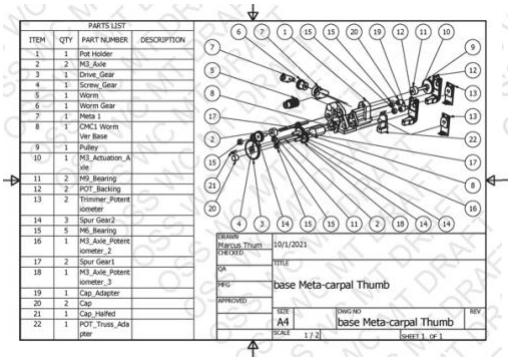
Figure 25: Clean BOX

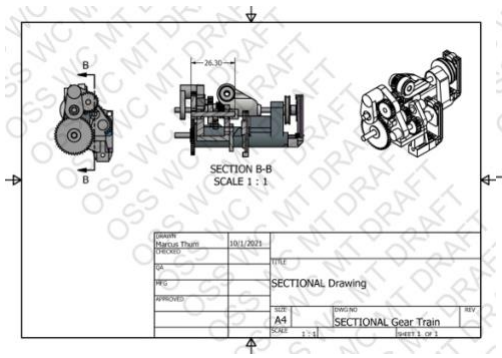
Clean BOX

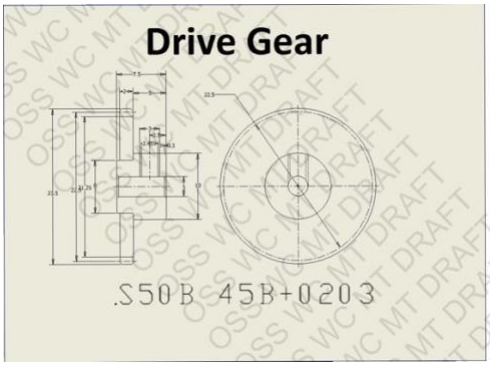
The Clean BOX was introduced and assembled after Braiding was done. It is done as a concept to show the Brading can be done cleaner. Clean BOXES can be searched online and are widely available for a quite a Hefty Price. I thought, why not try to build one!

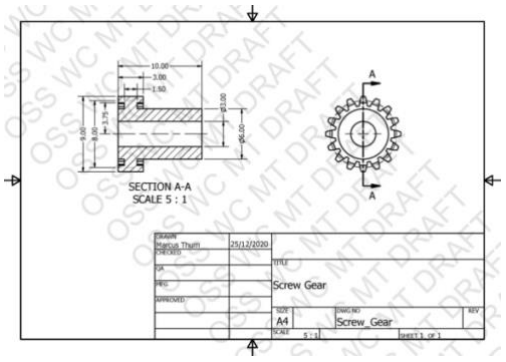
4.2 Bio-Mechanical Hand

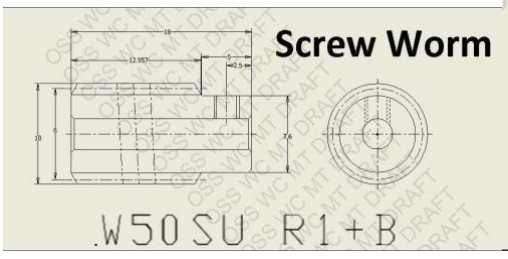
4.2.1 Thumb

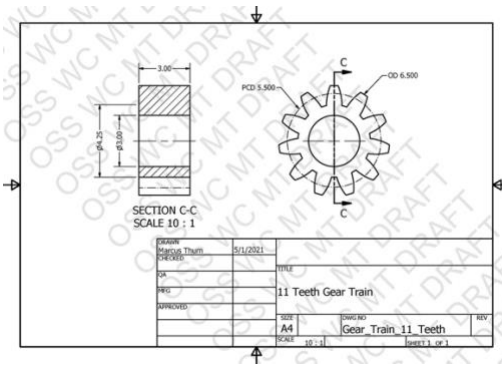








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SIZE
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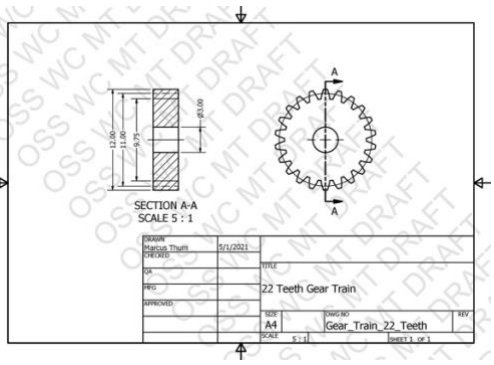
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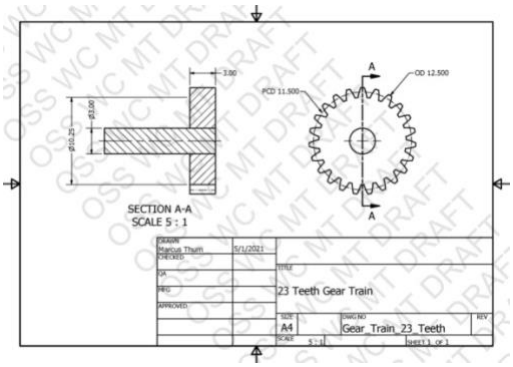
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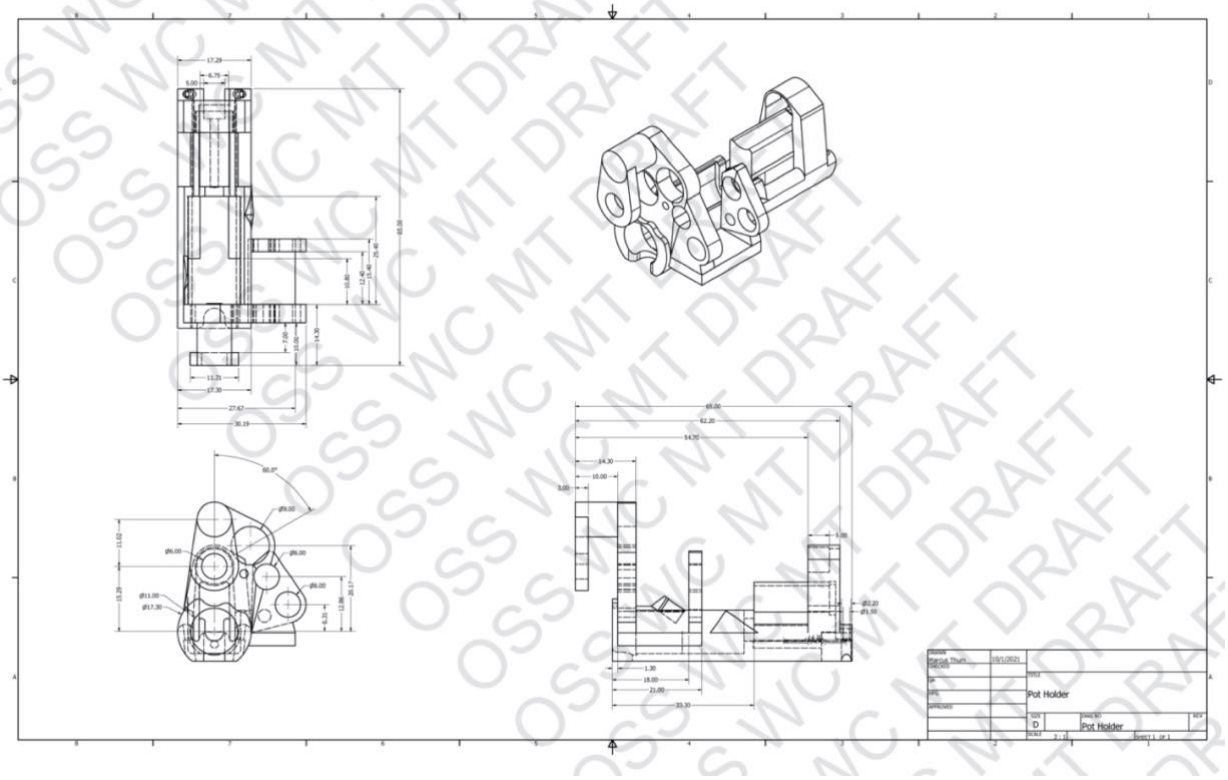
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10/1/2021
CHECKED
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MFG
Pot Holder
APPROVED
SIZE
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DWG NO
Pot Holder
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2 : 1
SHEET 1 OF 1

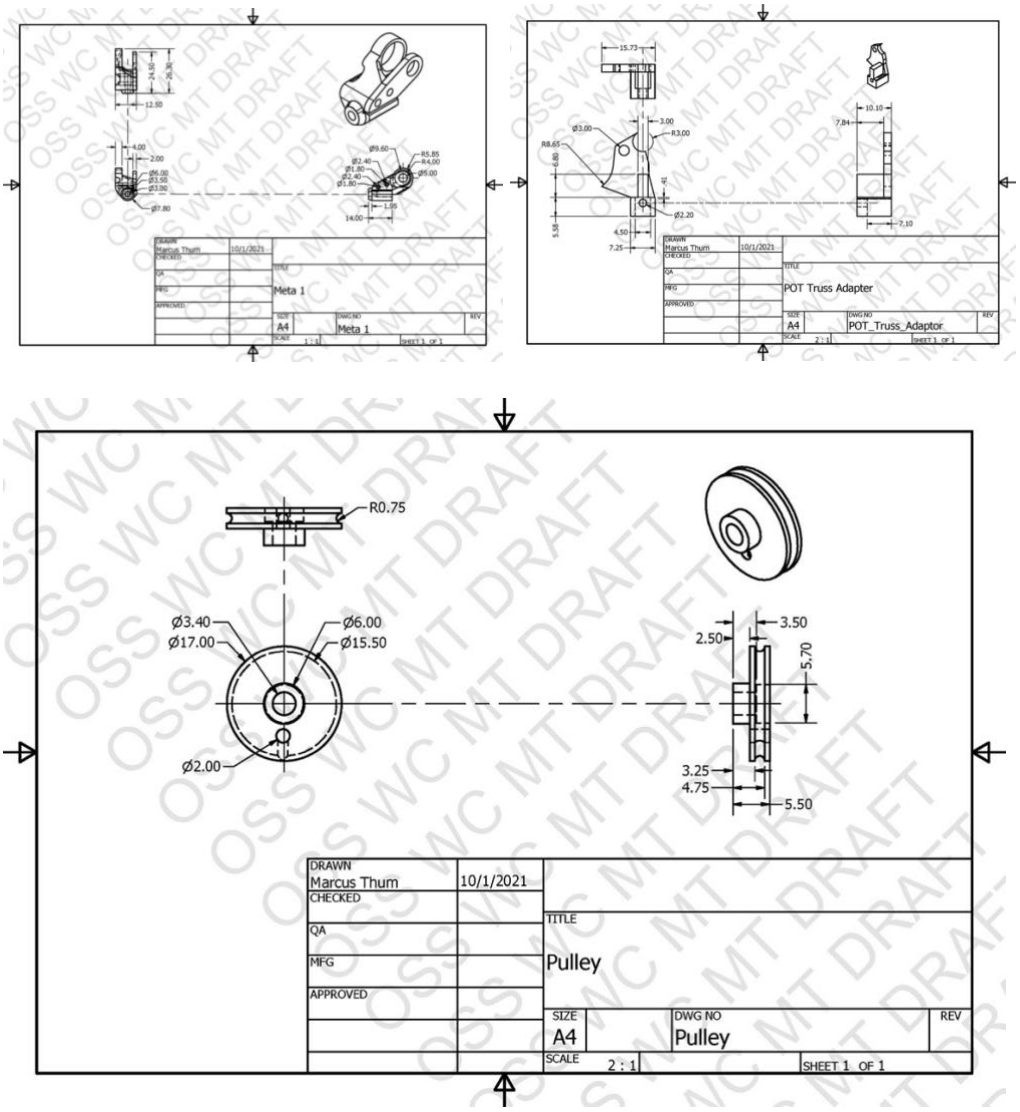


Figure 26: Drawings

Drawings

The Bio-Mechanical Thumb Design was adapted from Will Cogley Nilheim Mechatronics. The Exploded View shows the Internal and External assembly of the Moving Parts that are needed to do the Flexion and Extension Movements. The Calculations and Mechanism Animations will be further shown below.

4.2.2 Calculations

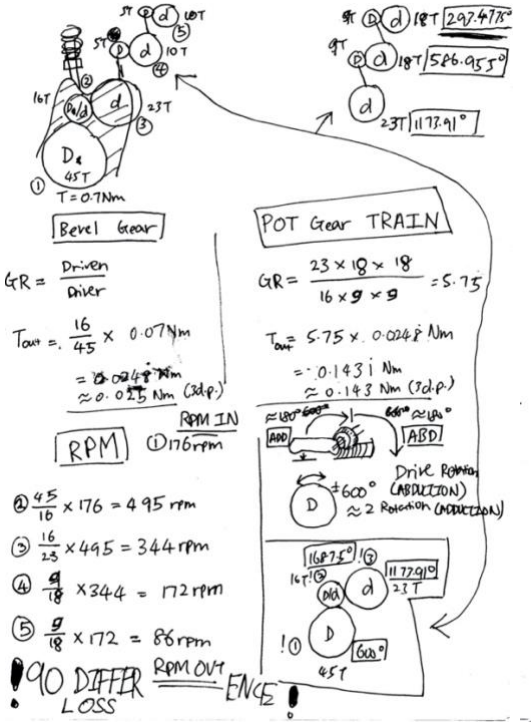


Figure 27: Torque, RPM and Angle

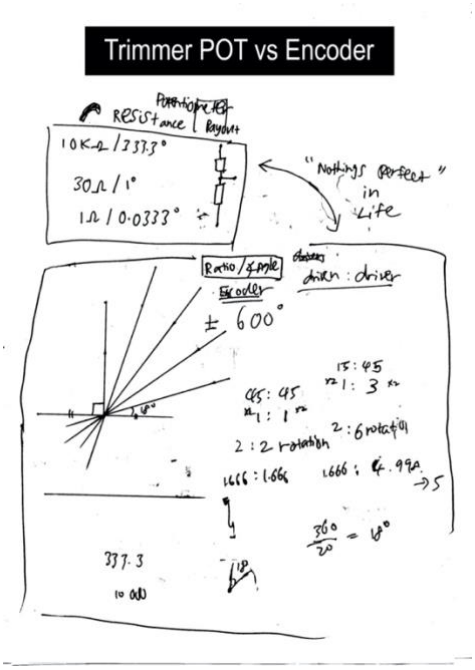


Figure 28: Trimmer POT vs Encoder

Calculations

The Drive Gear and Gear Train Torque and RPM has been calculated (see Figure 27). The turning angle is also taken into consideration since the gear train is used to turn the Trimmer Potentiometer. It is to accurately track the rotation of the DC Motor. The Brushed DC Motor lacks an encoder, taking it consideration. The Gear Train converts roughly 600 degrees to 293.47 degrees. The Trimmer Potentiometer is being compared against the Encoder, measuring out the turning accuracy. The Encoder measures out at 18 degrees. The Trimmer Potentiometer measures out at 30 Ohms per degree.

4.2.3 BOM List

CONFIDENTIAL

Bill Of Materials For Robotics Hand - (Intern) Thum Wei Aun Marcus

4.0 Enforcement

All users will be held accountable for the loss of the organization's confidential data. Non-compliance and violations of this Policy will be investigated, leading to disciplinary actions in accordance with the organization's disciplinary procedures.

Users must also not engage in any activities that will be in violation of National Electronic Health Records (NEHR) System Terms of Use and the laws of Singapore, in particular (but not limited to), the Computer Misuse and Cybersecurity Act (Cap 50A), Copyright Act (Cap 63), Spam Control Act (Cap 311A), Undesirable Publications Act (Cap 338) and the Personal Data Protection Act 2012 as may be amended from time to time.

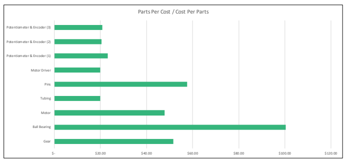
NO.	Item Description	Qty.	Amount ($)	Link (HTML)
1	Drive Gear (S50B45B+0203)	1	$ 10.45	https://sg.misumi-ec.com/vona2/detail/221000069279/?HissuCode=S50B45B%2b0203&PNSearch=S50B45B%2b0203&KWSearch=S50B45B%2b0203&searchFlow=results2type
2	Screw Gear (101281016FAR)	1	$ 0.81	https://sg.element14.com/huco/101281016far/gear-spur-acetal/dp/3471172?st=spur%20gear%20m0.5
3	Worm Wheel Gear (G50B20+R1)	1	$ 21.15	https://sg.misumi-ec.com/vona2/detail/221000110917/?rid=rid3
4	Worm Wheel Screw (W50SUR1+B)	1	$ 19.30	https://sg.misumi-ec.com/vona2/detail/221000120367/?HissuCode=W50SUR1%2bB&PNSearch=W50SUR1%2bB&KWSearch=W50SUR1%2bB&searchFlow=results2type
5	Miniature Ball Bearings [OD9] (F-W603ZZ1/1K)	10	$ 4.86	https://sg.misumi-ec.com/vona2/detail/221000058378/?HissuCode=F-W603ZZ1%2f1K&PNSearch=F-W603ZZ1%2f1K&KWSearch=F-W603ZZ1%2f1K&searchFlow=results2type
6	Miniature Ball Bearings [OD6] (F-WA673SSA/1K)	10	$ 5.18	https://sg.misumi-ec.com/vona2/detail/221000058378/?HissuCode=F-W603ZZ1%2f1K&PNSearch=F-W603ZZ1%2f1K&KWSearch=F-W603ZZ1%2f1K&searchFlow=results2type
7	MG996R Motor: Parallax Inc Servo Servo Motor, 140 mA, 4 → 6 V, 27 Ncm	1	$ 24.13	https://sg.rs-online.com/web/p/dc-motors/7813058/?cm_mmc=SG-PLA-DS3A-_-google-_-PLA_SG_EN_Automation_%26_Control_Gear_Whoop-_-(SG:Whoop%21)+DC+Motors+(2)-_-7813058&matchtype=&pla-478037629623&gclid=EAIaIQobChMIgODc2p677QIV2AkrCh0_vgAgEAQYASABEgI-VfD_BwE&gclsrc=aw.ds
8	MG90s Motor	1	$ 3.80	https://www.lazada.sg/products/on-sale-mg90s-micro-metal-gear-9g-servo-for-rc-plane-helicopter-boat-car-48v-6v-i1325044493-s5547278673.html?exlaz=d_1:mm_150050845_51350205_2010350205::12:1025267241!54483208270!!!pla-297963845945!c!297963845945!5547278673!283193235&gclid=EAIaIQobChMI9vWKop-77QIVgiQrCh3Sgg6xEAQYCiABEgIASvD_BwE
9	RS DC Brushed DC Motor	1	$ 19.93	https://sg.rs-online.com/web/p/dc-motors/7522002/
10	PTFE Tubing Teflon (ID = 1mm), ID = Internal Diameter	2	$ 10.00	https://www.lazada.sg/products/3d-printer-part-1meter-bowden-extruder-ptfe-tube-teflon-pipe-for-j-head-hotend-v5-v6-175mm-3mm-filament-id-2mm-1mm-3mm-od-4mm-i1124444421-s4356288934.html?spm=a2o42.searchlist.list.1.7c16150eY7t4XN&search=1
11	Dowel Pins – Straight: MSC3-40	19	$ 3.03	https://sg.misumi-ec.com/vona2/detail/110300255260/?KWSearch=dowel%20pin&searchFlow=results2products
12	Adafruit 16-Channel 12-bit PWM/Servo Driver - I2C interface - PCA9685	1	$ 19.88	https://www.adafruit.com/product/815
13	SN-360 Rotary Encoder	2	$ 3.26	https://shopee.sg/Arduino-360-Degree-Encoder-i.199385036.5407549250

CONFIDENTIAL

14	CJMCU-103 Rotation Angle Sensor	2	$ 8.33	https://shopee.sg/Potentiometer-103-module-rotation-angle-sensor-SV01A103AEA01R00-fine-tuning-potentiometer-i.133454223.3354812787
			$ 7.01	https://shopee.sg/Arduino-199-MCU-103-Rotation-Angle-Sensor-Module-i.319177698.6256924889
			$ 7.17	https://sea.banggood.com/CJMCU-103-Rotation-Angle-Sensor-Module-SV01A103AEA01R00-Trimmer-10K-Potentiometer-Analog-Voltage-p-1221722.html?cur_warehouse=CN

Gear	$ 51.71
Ball Bearing	$ 100.40
Motor	$ 47.86
Tubing	$ 20.00
Pins	$ 57.57
Motor Driver	$ 19.88
Potentiometer & Encoder (1)	$ 23.18
Potentiometer & Encoder (2)	$ 20.54
Potentiometer & Encoder (3)	$ 20.86
TOTAL (Option 1)	$ 320.60
TOTAL (Option 2)	$ 317.96
TOTAL (Option 3)	$ 318.28

Take a Graph



Sourcing

The BOM List has been generated for the Bio-Mechanical Thumb.

I started to source for the gears, Ball Bearing, Motor, Tubing, Pins, Motor Driver and Potentiometer & Encoder.

I sourced it from,

1. Misumi,
2. Element14,
3. RS Online,
4. Lazada,
5. Adafruit,
6. Shopee,
7. BangGood,

I researched and chose the components, listing it out. I compared the specifications and paired the gears that are needed. I referred to Will Cogley's YouTube Video.

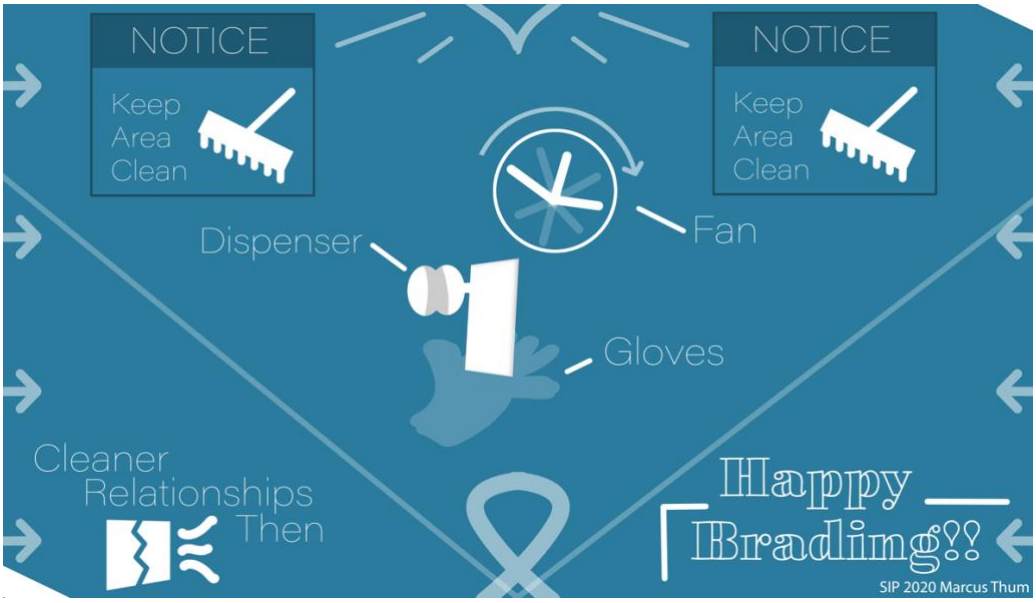
4.2.4 Mechanism ANIMATION

Video Progress	I will provide the video with the progress I made through visual representation. The videos will all be linked to YouTube. **Video:** https://drive.google.com/file/d/1gQWfYiH3H9nXS40WLnBrDsW8SlzZfJ6v/view?usp=sharing

4.2.5 FINAL Visualised RENDER

4.3 Cleaner Than Relationships BOX

4.3.1 Panel


NOTICE
Keep
Area
Clean
NOTICE
Keep
Area
Clean
Dispenser
Fan
Gloves
Cleaner
Relationships
Then
Happy
Brading!?
SIP 2020 Marcus Thum


NOTICE
Keep
Area
Clean
NOTICE
Keep
Area
Clean
Dispenser
Fan
Gloves
Cleaner
Relationships
Then
Happy
Brading!?

5. CONCLUSION

I have finally achieved the objectives of the project and developed aided printed solutions for Braiding. The Braiding, Aided Printables and Bio-Mechanical Thumb have been successfully deployed with nice Design, Calculations, Sourcing, Handling, Packaging and Rendering Solutions. The Bio-Mechanical Hand was one that I thought I would not get Funding for. However, I managed to generate the Blueprints for it, ready for grading.

I successfully transitioned between the Braiding and Bio-Mechanical hand, applying what I have learned through thorough Research and Development. Massive Prototyping is a part of Experimentation, with Success and Failures. The excessive Usage and Practice of SafeEntry Practices during the time of Braiding reduced the spread of Infection and Contamination.

I am quite proud of what I have accomplished, and I hope you have enjoyed this as much as I did. I remembered a time before, when I was scouring the planet for Ideas and Inspiration, beyond what was possible to Accomplish and Invent.

Do me good, thank you for your time!

6. Acknowledgements

I would like to acknowledge Mr Tan Kim Cheng and Mr Wong Yoke Rung for giving me this unique opportunity for a once in a lifetime partnership between Singapore General Hospital and Temasek Polytechnic. I would also like to thank the department for coordinating this SIP Journey, through the various curriculum. I was able to make the transition through the Work and Presentation beyond just the confines of Education. This Report is part of the Deliverables, required for the Graduation of Class 2021, Thum Wei Aun Marcus, 1801321I, 2021.

7. References

All materials are linked to External Sources.

Will Cogley’s YouTube Channel: https://www.youtube.com/watch?v=Iej2jkwU-ts&t=160s

8. Appendices

The report has been stylised to make reading easier. All the Referenced Content and Text have been written with focus and intent. I hope you piece it together and enjoy the writeup as much as I do. Thank you for your understanding.