Project Deliverable C: **Conceptual Design, Project Plan, BOM and Feasibility Study**

GNG 2101 – Intro. to Product Dev. and Mgmt. for Engineers

Faculty of Engineering – University of Ottawa

Objective:

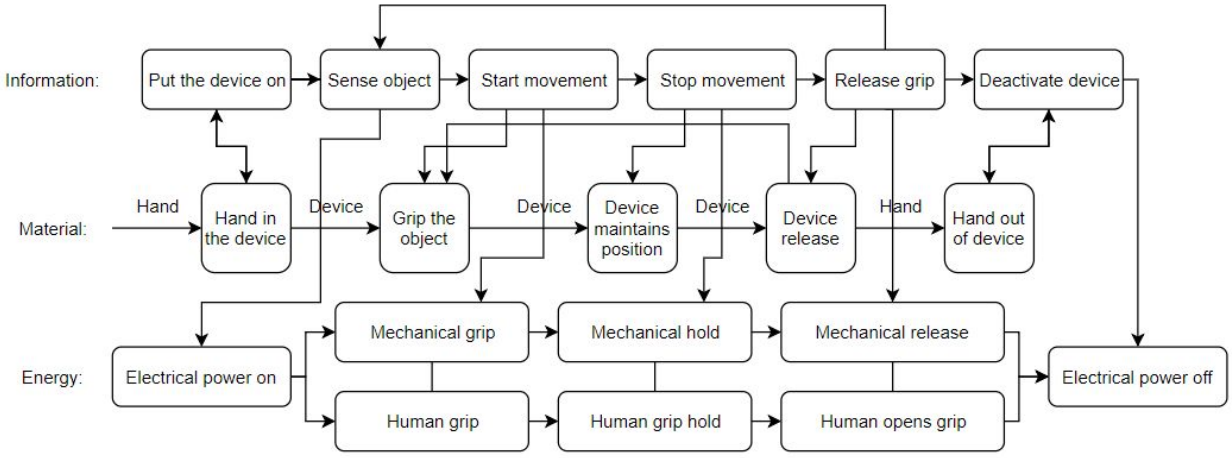
Develop a conceptual design for your product and create a plan for completing multiple prototypes in time for Design Day. Provide a bill of materials and parts (BOM), as well as a feasibility study to verify the viability of your proposed concept.

Instructions:

This project deliverable is split into two parts and will *require a lot of work* from all members of your team. To be successful, you will need to start early. Create a separate document for each part, but submit them together.

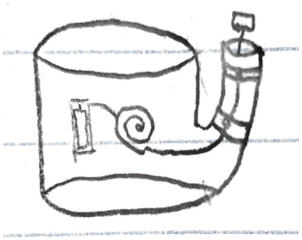
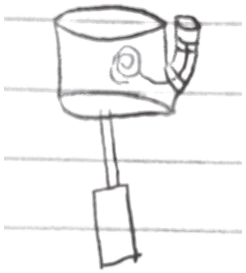
C.1 Conceptual Design. As a group:

1. **Based on customer needs, clarify core functionality by breaking down required product functions (functional decomposition) into smaller basic sub-functions, identifying external sub-system boundaries.**



2. **Provide a minimum of 3 product concepts per team member (clearly identify each concept's creator).**
3. **Analyze and evaluate all concepts provided by each team member based on the target specifications of Project Deliverable B. Use simple calculations and/or**

simulations to make decisions. Justify the process and methods used for analysis and evaluation.

<table>
<tr><td colspan="3">Product concepts by Doga</td></tr>
<tr><td>Solution 1:
  </td><td>Solution 2:
  </td><td>Solution 3:
  </td></tr>
<tr><td>Description:
The thumb grip is controlled by the pinky and the ring finger. As one or both of those fingers moves in gripping motion, the thumb will also start to move in a gripping motion

Analysis:
Pros:
- The device provides a lot of freedom for the first 2 fingers and barely hinders the pinky and ring fingers.
Cons:
- If the client wants to move her thumb without those fingers, the device will not assist in that motion</td><td>Description:
There is a pressure sensor on the tip of the thumb and as it senses pressure the glove aids in giving strength. A servo motor that is attached to a battery pack is used.

Analysis:
Pros:
-Simple mechanism
-Provides a lot of freedom for the fingers
-Cost efficient
Cons:
-Hinders the tip of her thumb
-If pressure sensor fails, there is no other mechanism to help it.</td><td>Description:
A muscle sensor is attached to the arm. When it senses the flexor pollicis longus or the flexor digitorum profundus, it activates the servo motor which helps flex the thumb.

Analysis:
Pros:
-Provides a lot of freedom for the fingers
Cons:
-Wires pass the wrist which may cause uncomfort.
-Expensive
-Complex mechanism</td></tr>
<tr><td colspan="3">Product concepts by Hongjian</td></tr>
<tr><td>Solution 1:</td><td>Solution 2:</td><td>Solution 3:</td></tr>
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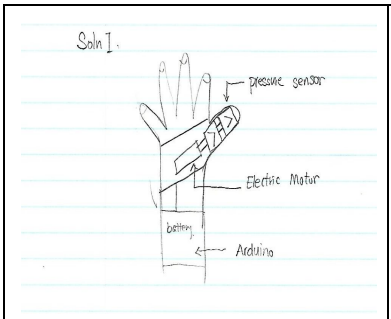
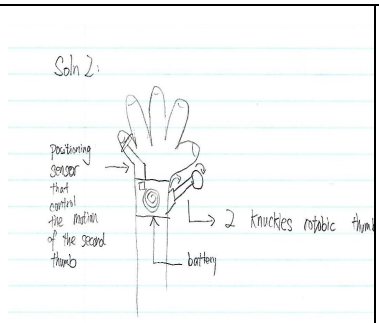
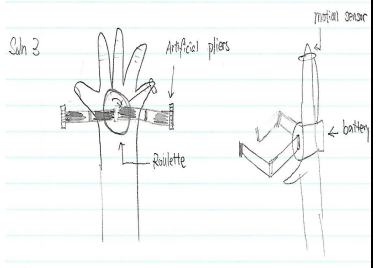
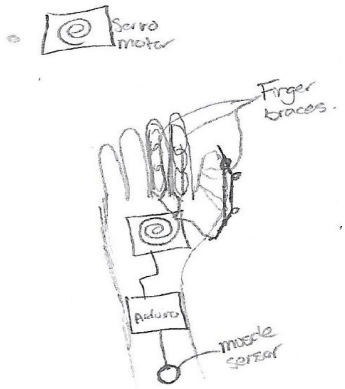
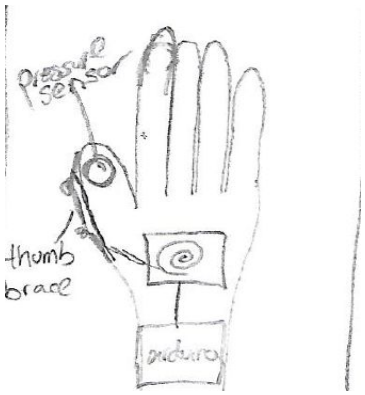
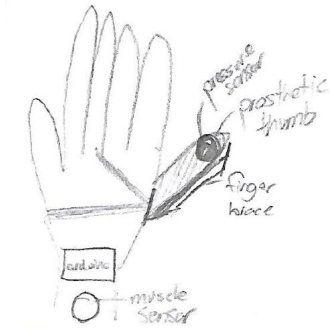
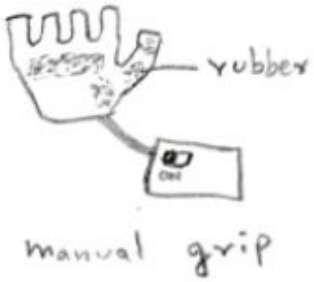
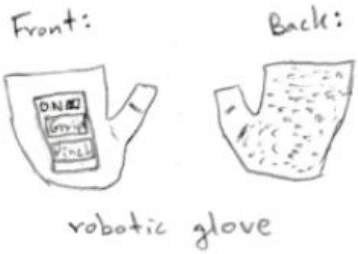
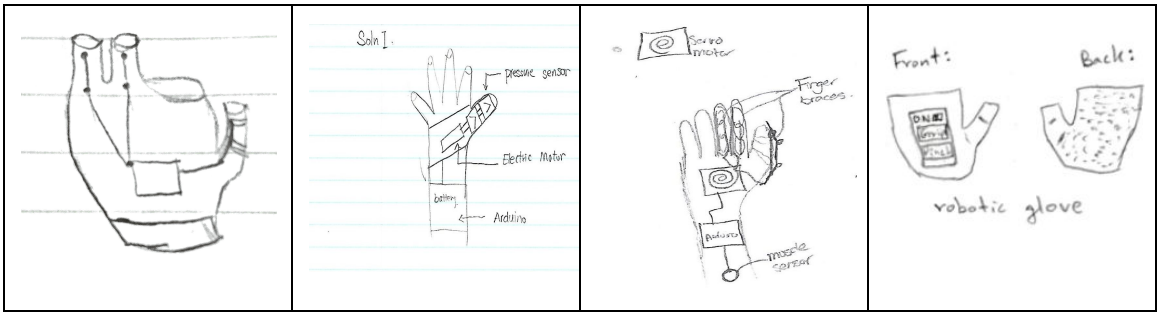
		
Description: The pressure sensor is located on the palm, and it will activate the motor to make gripping motion once it sensor the pressure Analysis: Pros: -The activation process can user friendly, they can activate the device using naturally motion -The device can solve the client's wish of doing pinching motion Cons: -the component are complex to build into a small scale	Description: A artificial thumb is made to assist the client to grip item. The robotic thumb is controlled by the little thumb's spring switch. When the little thumb bend, the device will activate and the thumb will grip item until the little thumb stop Analysis: Pros: -The activation process can user friendly, they can activate the device using naturally motion Cons: -the user cannot get touching feeling on the robotic thumb, therefore when the user want to grip small item, it is hard to pick it up	Description: A plier-liked device is attach in the palm. The device is activated by the motion of the little finger. Once activated, the device can grip item. Analysis: Pros: - Can provide better gripping performance to heavy item -Easy to build and construct Cons: -The user lose the touch feeling when gripping item -Not suitable for grip small item such as needles
Product concepts by Liam		
Solution 1:	Solution 2:	Solution 3:

		
Description: On the thumb, ring finger and middle finger there are finger braces to power the gripping motion. These are controlled by an arduino being fed information from a muscle detecting sensor. Analysis: Pros: - Most natural feel on hand - A lot of control due to muscles already existing controlling the device - Client likes the idea of using a muscle sensor Cons: - Less cost effective -Many components	Description: On the thumb there is a finger brace to power the gripping motion. This is tightened by a servo motor controlled by the arduino. A pressure sensor on the thumb controlled the gripping motion. Analysis: Pros: - Minimal coverage of hand - Simple design - Cost effective Cons: - Less gripping power than possibly needed - Only pressure sensor could lack needed control	Description: A prosthetic thumb is controlled by a muscle sensor to act as the clients regular thumb should along with their actual thumb. Pressure sensor on prosthetic adds safety to not grip too hard. Analysis: Pros: - Less restrictive than other solutions as only one strap to attach to the hand -Powerful gripping power is possible Cons: - Less precise than other solutions
Product concepts by Nishchal		
Solution 1:	Solution 2:	Solution 3:

		
Description: A glove with rubber as a texture on the palm side for better grip. Manual on/off button for the grip assistance. Analysis: Pros: -Cost effective -Able to hold bigger battery for longer product use -Easy to put on Cons: -Extra carry-on -Very delicate -Not water resistant -No measure for minimum gripping strength	Description: A glove with only a slot for the thumb. Fully covered rubber texture on the palm side and a plate with buttons on the other side to turn the device on, to initiate a gripping posture and to initiate a pinching posture. Analysis: Pros: -Easy to put on -Fingers are free except the thumb -No carry-on Cons: -Unable to hold bigger battery so, shorter product use -Not water resistant	Description: A device that stops the thumb from locking and moves it in a pinching and gripping posture. Analysis: Pros: -Very light -Easy to use -Cost effective Cons: -Very delicate -Extra carry-on -Not water resistant -No measure for minimum gripping strength

4. **Choose one or a few promising solutions you wish to develop further based on your evaluation.**

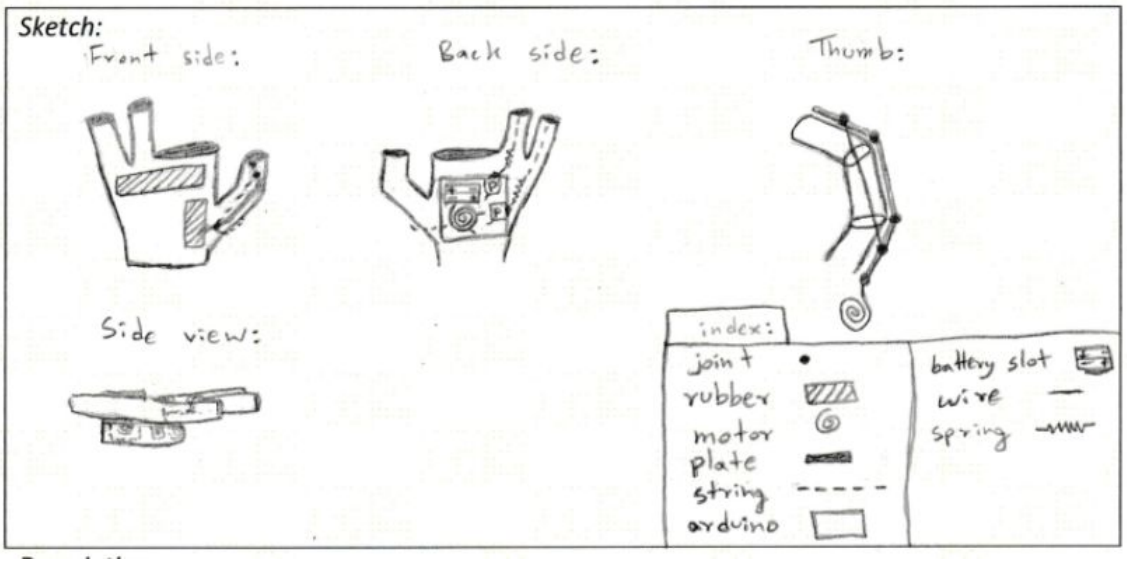
Doga's Choice	Hongjian's Choice	Liam's Choice	Nishchal's Choice



5. **Develop a group design concept which is either an integration or modification of the promising concepts chosen in the previous step, or a brand-new concept created from these ideas. Justify your approach.**

   A device with four finger slots for little finger, ring finger, thumb and a slot for other two fingers. It has an arduino attached at the back with battery, motor and pressure sensors connected with a spring each. The little finger pull generates more force, thus activating the motor to pull the thumb for a gripping hand posture. The ring finger pull generates less force, thus activating the motor to pull the thumb for a pinching hand posture. The rubber pads are located near the palm of the hand to create a better grip due to friction.

6. **Visually represent (sketch, diagram, CAD model, etc.) your group concept.**



7. **Provide a few lines explaining your concept's relationship to the target specifications, as well as its benefits and drawbacks.**

Metrics Number	Metrics	Units	Acceptable Value	Ideal Value	Reason for the values	Relationship to the target specification
1	Total mass	g	< 500	< 300	The product needs to be as light as possible. Boxing gloves weigh 250g on average	The material for our project are mainly built by plastic. The motor, arduin, and battery pack can be limited less than 150g
2	Minimum gripping strength generate by the device	kg	> 15	> 20	This is the average grip strength.	The servo motor is responsible for providing the power.
3	Device size for client	Size	=Large Size	=Medium Size	The client prefers medium or large glove sizes.	A pair of medium size glove as the device platform
4	The time device can last	hour	< 3	< 6	Client will use the product for a long duration.	The device depends on how long the battery lasts. Since there are only motors and pressure sensors using up the battery, the device should last at least three hours.
5	Water Resistant	bars	No	Yes	Product might come in contact with	The electrical components are located on the

					water	back of the hand close to the wrist. This means that the fingers can be in contact with water without damaging the device. However, if the electronics get wet, the device will be damaged.
6	Manufacturing Cost	$ CAD	< 100	< 90	Competitive price must be lower than competitions.	The bill of materials for this solution shows that the project should cost only around $60..
7	Time for client to take off the device	minute	< 2	< 1	Product must be easily removable.-	The device is built on a glove. All the component are covered in a box on the back of the glove, therefore, it should be easy for the client to take off the device
8	Instills pride	Subjective	A bit	A lot	Meets requirements and satisfies customer needs	The 3D printing material is colorful which is client's favorite
9	Wireless	qi	No	Yes	Product will	The proposed

	Charging				be able to recharge quickly and without much effort.	solution does not implement wireless charging but this was not required.

C.2 Project Plan, BOM and Feasibility Study. Using the Project Management Workbook provided in class:

1. **Develop a project plan and ensure you address each point in the workbook.**
2. **Provide a detailed bill of materials and parts (BOM) for each prototype, which will be presented to your project managers for approval and purchase. You will be given up to $100 for the development of your final prototype only.**
3. **Conduct a feasibility study by discussing the five TELOS factors.**

It is highly likely that you need to modify your concept or your plan later on in the design process. Therefore, it is critical that you document your ideas and processes properly.

C.2

Project Management Workbook

GNG 2101 – Intro. to Product Dev. and Mgmt. for Engineers

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Objective:

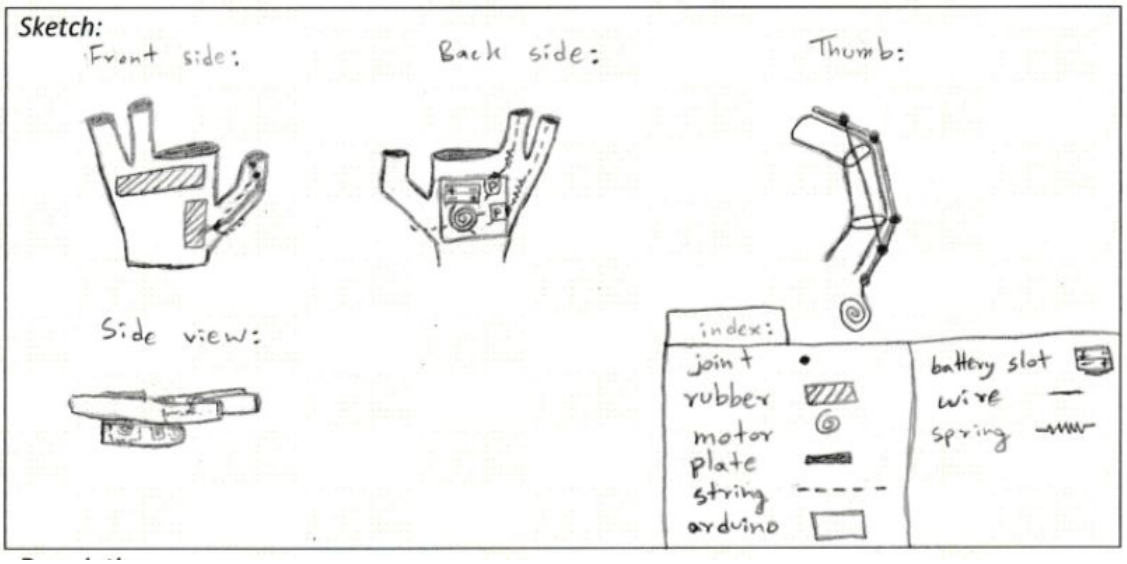
Conduct a feasibility study, provide a bill of materials and parts (BOM) and develop and track a project plan.

Initiation:

Problem Statement (provide the problem statement you developed in Project Deliverable B):

To design a comfortable device that will help the client perform gripping and pinching motions.

Chosen Solution (Provide a sketch and short description of your chosen solution):



Description:

A device with four finger slots for little finger, ring finger, thumb and a slot for other two fingers. It has an arduino attached at the back with battery, motor and pressure sensors connected with a spring each. The little finger pull generates more force, thus activating the motor to pull the thumb for a gripping hand posture. The ring finger pull generates less force, thus activating the motor to pull the thumb for a pinching hand posture. The rubber pads are located near the palm of the hand to create a better grip due to friction.

Solution benefits/drawbacks and implementation concerns:

A benefit of this device is the minimal coverage it provides. The first two fingers are completely free, while the pinky and ring fingers are only covered until the proximal phalanges. This allows the use her fingers without a glove getting in the way. The rubber pads also help with gripping, making it easier for the user to hold certain objects. The

compact size of the glove and its light weight allows for more freedom and it will not fatigue the hand. The device has a simple mechanism to help with the pinch motion, which is easy for the client to understand. A big drawback is that the device is not waterproof. While the fingers can get wet, the device may fail if submerged.

Feasibility Study (provide strengths and weaknesses of solution based on TELOS factors):

Technical: **Does your team have enough expertise and technical resources?**

Our team has most of the expertise and technical resources required to do most of the prototypes designed for this solution. The technology that will be used in the prototypes are an arduino circuit, a MyoWare muscle sensor, and pressure sensors. The team members have all have different educational backgrounds which gives us a different expertise in many fields. Additionally, the teaching assistant and project manager have used these devices before and can assist us when we require their help. Overall, the technology to develop a working prototype exists and we have sufficient help to design it, if required.

Economic: **Can the cost of your project be reasonable?**

The key components like the Arduino, electric motor, sensor can be used multiple times. For other parts, we can create by doing 3D printing. Also, the estimated cost of our final prototype is less than $100 so we have financial space to adjust our plan during our

prototyping. The man-power required for project is free, so there is no extra cost required.

Legal: **Are there any legal issues with releasing your solution to the public?**

We use open source platform to generate our solution, therefore, we don't aware any legal issues can take place to our project. There also has been no patents found on the designed device.

Operational: **Are there any organizational constraints that will prevent your success?**

The only organizational constraint we have that could prevent us from success is the assigned deliverables. The deliverables take up a significant amount of time that could be spent in the actual development of our prototypes. Although the

deliverables represent an important stage of project development and management, it would be much more efficient to put the time into the creation of our device.

Scheduling: **What are the deadlines and are they reasonable for your solution?**

Our deadline is March 29th for our final prototype. With the complexity of the on design we selected, this shouldn't be too difficult to meet. However, the initial prototype/3D modelling of the initial prototype having a deadline of February 12th , there is a critical time constraint here making our only option to do rough sketches paper. As for the other reports and deliverables, they should be easy to meet their respective deadlines as we are given at least a week to complete each of them.

Planning:

Task List, Task Ownership and Task Deadline:

You must use Trello (www.trello.com) to track task progress. PMs and TAs must be added to your project Trello to confirm adequate progress according to your project plan.

Legend **(define short forms used in the table below):**				
#	***Task Name***	***Task Owner***	***Required Resources***	***Completion Deadline***
1	**D – Detailed Design and Prototype 1**	**Everyone**	**Prototype 1**	**Feb 10**
2	**E – Project Presentation**	**Everyone**	**Prototype 1**	**Feb 11-15**
3	**F – Business Model**	**Everyone**		**Mar 3**
4	**G – Prototype 2 & Customer Feedback**	**Everyone**	**Prototype 2**	**Mar 10**
5	**H – Economics Report & 1 Minute Video**	**Everyone**	**Prototype 2**	**Mar 17**
6	**I – Design Day**	**Everyone**	**Prototype 3**	**Mar 29**
7	**A- Grip Mechanism prototype 1**	**Hongjian Doga**	**Cardboard Scissor Glue Tape String**	**Feb 5**
8	**B - Spring Activate prototype 1**	**Liam, Nish**	**Spring String Cardboard Glue Scissors Tape**	**Feb 5**

9	**C- Comfortability of wrist movement prototype 1**	**Everyone**	**Cardboard Tape Scissors**	**Feb 5**
10	**- proper movement of the thumb (1 - comfort of bending the hand with the glove on (1 - elastic string vs spring and non-elastic string(2 - placement of the strings in the glove(1 - potential grip strength loss due to spring/string(3 - turning on/off the push button with a pull motion from the fingers (2 - activation/ deactivation of the motor (2 - movement speed of the thumb(2 - battery durability (3 - overall weight (3 - servo motor test (2**			
11	**L - 3D Print Finger Supports (Prototype 2)**	**Doga**	**Computer, std files**	**March 7**
12	**M - Assembling the Device to the Glove (Prototype 3)**	**Hongjian**	**All components**	**March 25**
13	**N - Model Finger Supports (Prototype 2)**	**Nish**	**Computer, solidworks**	**March 5**
14	**O - Program Arduino (Servo Motor) (Prototype 2)**	**Liam**	**Computer, Arduino,**	**March 6**

			servo motor	
15	**P - Program Arduino (Switches/Buttons) (Prototype 2)**	**Nish**	**Computer, Arduino, buttons**	**March 7**
16	**Q - Assemble the Circuit (Prototype 3)**	**Hongjian**	**Wires, Servo, Buttons, arduino**	**March 20**
17	**R - Sketch out Circuit (Prototype 2)**	**Liam**	**Computer, circuit program**	**March 5**
18	**S - Test Circuit (Prototype 2)**	**Hongjian Nish**	**Wires, Servo, Buttons, arduino**	**March 10**
19	**T - Model 3D printing for button switches (Prototype 2)**	**Doga**	**Computer, solidworks**	**March 5**
20	**U - 3D print button switch mechanisms (Prototype 2)**	**Nish**	**Computer, std files**	**March 7**
21	**V - Test button mechanisms (Prototype 2)**	**Doga Liam**	**Mechanisms, buttons, arduino, wires, computer**	**March 7**
22	**W - Test finger supports (Prototype 2) (Prototype 2)**	**Hongjian**	**supports, arduino, servo, wires, computer**	**March 7**

23	**X - 3D print the device cover (Prototype 3)**	**Hongjian**	**Computer, std files**	**March 24**
24	**Y - 3D model and print motor spool (Prototype 2)**	**Doga**	**computer, solidworks**	**March 5**
25	**Z - Order final materials**	**Everyone**	**Computer**	**Feb 10**
26	**ZA - Gather prototype materials**	**Everyone**	**Computer/ in person**	**Feb 15**
27				
28				
29				
30				
31				
32				
33				
34				

Prototype Bill of Materials and Parts (BOM):

Part Name	*Description (Identify prototype #)*	*Quantity*	*Unit Costs ($CAD)*	*Extended Cost (Qty x $)*	*Actual Cost (Qty x $)*
Push Button	**A button to read a finger grip motion from the little finger and the right finger**	**2**	**4.95**	**9.90**	**9.90**
Glove	**To house the device and hold it onto hand of client**	**1**	**15.00**	**15.00**	**15.00**

Servo motor	**To spool strings used to activate fingers/thumb**	**1**	**30.00**	**30.00**	**30.00**
Arduino Nano	**Microcontroller to control the device**	**1**	**22.00**	**22.00**	**22.00**
String	**To help manipulate the plastic parts and cause gripping power**	**#**	**5.00**	**5.00**	**5.00**
Wires	**To wire the device to the arduino**	**#**	**11.95**	**11.95**	**0.00**
PLA 3D printer filament	**For various parts to manipulate the hand grip**	**#**	**Free**	**Free**	**0.00**
Rubber pads	**Provides extra grip in the palms**	**#**	**3.45**	**3.45**	**3.45**
Battery pack	**Holds batteries to power device**	**1**	**5.00**	**5.00**	**5.00**
Battery	**To power up the device**	**1**	**5.00**	**5.00**	**5.00**
Spring	**To execute on/off of the push button**	**2**	**0.86**	**1.72**	**Free**
Elastic String	**To execute on/off of the push button**	**1**	**0.40**	**0.40**	**Free**
Needle	**To weave parts on the glove**	**1**	**0.26**	**0.26**	**Free**
Thread	**To weave parts on the glove**	**1**	**0.10**	**0.10**	**Free**

			Total	**$109.78**	**$95.45**