Design Project 4 – Not a Pun, It's Real Life

EasyWrite + EasyPen

IBEHS 1P10 – Health Solutions Design Projects

Tutorial 01

Team 2

Pranav Chandrakumar (chandp19)

Mariam Mohamed (moham68)

Ryan Junejo (Junejr2)

Submitted: Wednesday, April 12, 2023

Course Instructors: Dr. McDonald and Dr. Sask

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Academic Integrity Statement

The student is responsible for performing the required work in an honest manner, without plagiarism and cheating. Submitting this work with my name and student number is a statement and understanding that this work is my own and adheres to the Academic Integrity Policy of McMaster University.

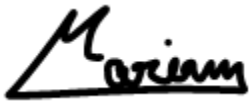
Pranav Chandrakumar 400455551

_____

(Student Signature)

The student is responsible for performing the required work in an honest manner, without plagiarism and cheating. Submitting this work with my name and student number is a statement and understanding that this work is my own and adheres to the Academic Integrity Policy of McMaster University.

Mariam Mohamed 400436137



_____

(Student Signature)

The student is responsible for performing the required work in an honest manner, without plagiarism and cheating. Submitting this work with my name and student number is a statement and understanding that this work is my own and adheres to the Academic Integrity Policy of McMaster University.

Ryan Junejo 400428039

_____

(Student Signature)

Summary of Design Objectives

Our project was centralized around the following statement: Design a wearable, discreet, compact, and purely mechanical device which increases Cheryl's handwriting abilities while limiting the negative implications imposed upon her due to her Multiple Sclerosis (MS). Furthermore, throughout the course of the creation of our device, several requirements were considered:

- Must improve her quality of life imposed by her MS
- Should improve her ability for physical motion with the limbs affected by her MS
- Should not exceed the physical size of her previously used device (if any)
- Should not hinder her day-to-day activities
- Should not be susceptible to drastic changes in weather

Description of Proposed Solution

The EasyWrite is an assistive device which serves to ease the physical hand motions required to use writing utensils, and is targeted at patients with MS. As a certain proportion of patients progressively lose control of their ability to use these tools, this device removes the onus on their wrist and hand muscles to use them, thereby increasing their ability to continue working with these utensils [1]. In essence, the device enables the user to use shoulder and elbow movement to write, rather than precise wrist and finger movement.

This device has two main components, the first of which being a bracelet, named the EasyWrite (Figure 4). This component features several ball bearings to serve as a free rotating wheel surface to ease bracelet movement along a writing surface. These balls housed at the bottom of the bracelet enable the user to utilize 360 degrees of monoplanar motion. Essentially, through the use of shoulder and elbow movement, the user can mimic similar handwriting abilities prior to diagnosis.

The secondary component of this device is named the EasyPen (Figure 5), and contains 2 subcomponents. The first of which is the magnetic grip, with the other being the magnetic finger covers. The finger covers are worn by the user, on the index finger and thumb, and the attraction between the covers and the grip serves to improve the user's grip strength to hold the writing tool. Furthermore, the magnetic grip of the EasyPen is modular in its design. It can be removed and attached to a multitude of writing utensils, thereby improving accessibility as well as the products overall viability for the end user.

In addition, this device is extremely compact in nature, and was created in such a manner to ensure the utmost discretion for the user. For instance, the elastic strap of the EasyWrite is adjustable, enabling the user to create a “snug fit” such that the device is flush with their hand. Furthermore, the entire device features dark colours, which synergizes with the compact design to create a low-profile physical design. Discretion and compactness are integral considerations to the design philosophy of the product, and each component of the final product is shaped, in some way, in accordance with this philosophy.

Overall, although this device was created for MS patients in particular, that does not limit its feasibility for patients who exhibit similar symptoms for those afflicted with the disease. For instance, for those who suffer from essential tremors, it’s not entirely impractical for them to utilize this device to assist in their use of writing utensils [2]. Our product improves the quality of life of all individuals who exhibit limited controlled motion with their fingers and wrists, as it ensures that these individuals can continue to use writing utensils in a similar manner relative to able bodied individuals.

Summary of Design Process

From the beginning of the design process, our team decided that one of the key areas regarding Cheryl we wanted to target was her problem with handwriting, as she had previously stated that was an issue she felt the most trouble with.

The initial concept the team started off with was the idea of a mechanical wrist brace. Dubbed “EasyWrite” this wrist brace would essentially act as a writing assistant guide to facilitate the movement of her wrist. The wrist brace would have a gyro system of balls at the bottom to allow for smooth guiding motion in a single plane of movement. To showcase the initial concept idea and design we assembled a small wrist brace fashioned out of cardboard, with foam balls taped down, in place of a free-rotating gyro.

Figure 1. Initial Cardboard Prototype
Source: Ryan Junejo

After further discussion we also realized that gripping the writing utensil would also prove to be an issue, so we decided to make a pair of finger sockets out of cloth to solve this dilemma. Upon brainstorming the different ways we could assemble such a wrist brace, we settled on the idea of 3D printing the device as it would allow us to fabricate a model of relatively high physical quality. We 3D modelled the bracelet to fit the dimensions of Cheryl's wrist as well as her writing position (both of which she provided to us via email).

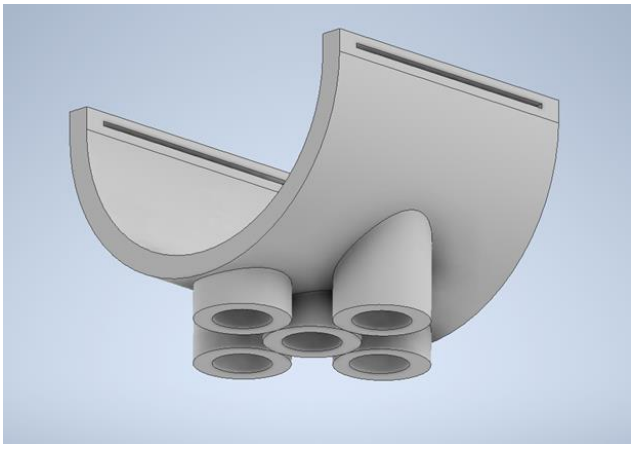


Figure 2: EasyWrite 3D Model
Source: Pranav Chandrakumar

We initially planned to 3D print the balls that would comprise the gyro however upon further consideration into how the mechanism would work we felt that the most efficient and practical route would be to outsource the balls from a third-party retailer. We also decided that instead of having a big network of balls that would act as the gyro, it would be much more stable to simply include 5 balls that each have their own designated socket for movement.

Upon assembling the balls into our newly printed prototype, we realized that although the spheres fit inside the designated sockets, it was difficult to hold them inside their respective sockets without overglueing them and hence hindering the movement. The solution we came up with was to 3D print small circular rings that would hold the balls to the sockets but still allow for them to rotate. Through the use of superglue we were able to successfully put our prototype together and assemble it correctly.

Figure 3: The Ball Bearings being fitted within the rings.

Source: Mariam Mohamed

We also attached elastic straps with buttons in order to allow the device to be fastened onto wrists of different sizes.

Figure 4: The final fabrication of the EasyWrite
Source: Ryan Junejo

Additionally, we were able to create a magnetic-based solution for the writing utensil grip strength issue. Named “EasyPen”, it essentially was a magnetic strip tied around a pen or pencil that connected to the magnets on the finger sockets that would magnetically attach to the writing utensil. This contraption

allowed the user to be able to grip the writing utensil without much force but still was loose enough to be able to be removed without much effort.

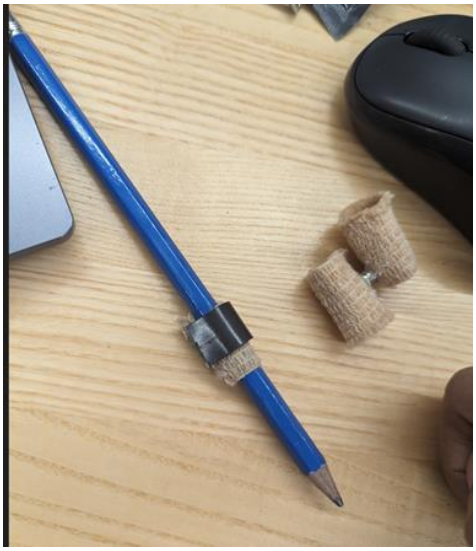


Figure 5: The EasyPen fabrication
Source: Ryan Junejo

After completing the fabrication of both the EasyBrace and EasyPen, we tested them out together to find a remarkable level of success and efficacy when it came to writing without straining the wrist and finger muscles extensively.

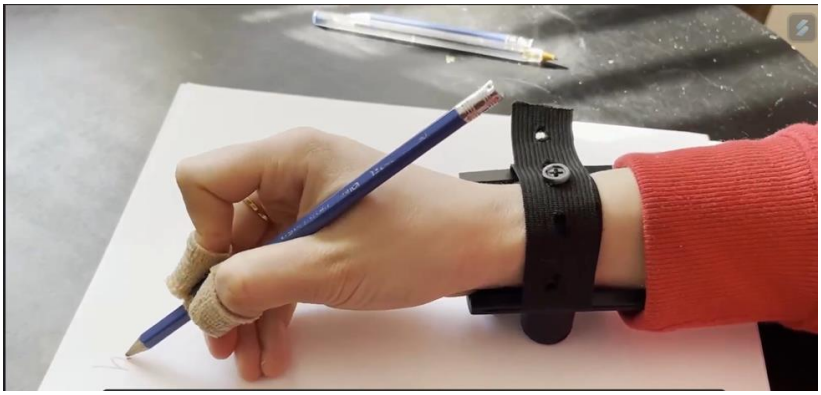


Figure 6: The team testing out the EasyWrite and EasyPen together
Source: Mariam Mohamed

Health and Safety Considerations

While the design of EasyWrite and EasyPen were made to fit patient comfort standards and ensure no safety concerns arise, there are always precautions to be taken into consideration when using any product.

Firstly, EasyWrite is composed of 90 percent 3D-printed material, leaving concerns regarding patient comfort due to the harsh material of the printed plastic used. To overcome such concerns, the process of filing down sharp edges resulting from the 3D-printed wrist brace took place to ensure smoother edges and providing the utmost comfort in wearing the wrist brace. Moreover, considering such factors, various design considerations were taken into account during the actual design process. While considering materials used for our design, it was vital to ensure the material used would accommodate any health concerns Cheryl may encounter, such as allergies to certain materials [3]. Our design was simple, yet effective; the only materials used were plastic, metal gyros, and an elastic strap, which were not mentioned as any material concerns. However, for further development and implementation, to ensure patients feel utmost comfort in wearing EasyWrite, a soft padding would be added onto the surface of the wrist brace to ensure a smoother wear and disregard any safety concerns regarding sharp surfaces or edges [4]. In addition to safety concerns around EasyWrite, ensuring the design of EasyPen remains safe is vital. For approval of the use of our design, it is crucial to ensure patients only use the bracelet for its intended purpose, as it would be a safety hazard for younger children due to its stiff material and the slightly heavy bulk of the gyro system installed in EasyWrite.

Overall, the creation of EasyWrite and EasyPen is designed in a way to limit any safety concerns, as the design serves as effective, yet simple, leaving little room for safety concerns. With the use of any product, it is vital to ensure it is only used for its intended purpose to avoid health and safety concerns and serve its purpose to help those struggling with Multiple Sclerosis to have a smooth and comfortable writing experience.

Summary of Contributions

Name	Roles	Responsibilities	Report Task
Pranav Chandrakumar	Manager	Modelling of wrist brace through Autocad + creation of all physical prototypes	Description of Proposed Solution
Mariam Mohamed	Coordinator	Design of physical gyro system and adjustable strap + taking video clips	Health and Safety Considerations
Ryan Junejo	Administrator	Completion of slideshow and video editing + design process contributions	Summary of Design Process

Reference List

[1] MS Society of Canada Quebec Division, “Search results,” *MS Society of Canada,* 2011. [Online]. Available: https://mssociety.ca/. [Accessed: 12-Apr-2023].

[2] A. Datta, N. Batra, and S. Pandey, “Primary writing tremor: Current concepts,” *Annals of Indian Academy of Neurology,* 2021. [Online]. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8370167/. [Accessed: 12-Apr-2023].

[3] M. T. Farcas, et. al “Acrylonitrile butadiene styrene (ABS) and polycarbonate (PC) filaments three-dimensional (3-D) printer emissions-induced cell toxicity,” *Toxicology letters,* 2019. [Online]. Available: https://pubmed.ncbi.nlm.nih.gov/31562913/. [Accessed: 12-Apr-2023].

[4] R. Shrestha, K. Krishan, and T. Kanchan, “NCBI,” *National Center for Biotechnology Information,* 2022. [Online]. Available: https://www.ncbi.nlm.nih.gov/books. [Accessed: 12-Apr-2023].

Appendices

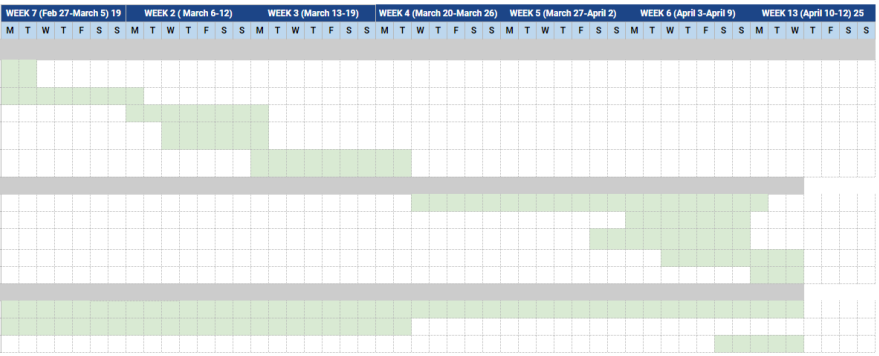
Appendix A: Project Schedule

Design Project 4: Preliminary Gantt Chart

Team Members Pranav, Kanglu, Ryan, Mariam **DATE** 2/27/23 - 4/12/23

Planned Timeline

TASK TITLE	START DATE	DUE DATE	DURATION
Milestones			
Milestone 0: Team Development and Project Planning	2/27/23	2/28/23	1
Milestone 1: Problem Definition	2/27/23	3/6/23	1
Milestone 2: Conceptual Design	3/6/23	3/13/23	3
Milestone 3: Preliminary Design (Design Review #1)	3/13/23	3/20/23	3
Milestone 4: Detail Design (Design Review 2)	3/20/23	3/26/23	6
Final Deliverables			
Medium Fidelity Prototype	1/30/23	2/27/23	29
Presentation Slide Deck	2/17/23	2/24/23	7
Oral Presentation	2/24/23	3/1/23	6
Design Project Report	2/20/23	3/5/23	14
Self and Peer Evaluation	3/3/23	3/5/23	3
Other			
Administrative Responsibilities	1/9/23	3/5/23	56
Conduct Individual Research	1/9/23	1/31/23	23
Practice for Design Expo Questions	2/27/23	3/3/23	5

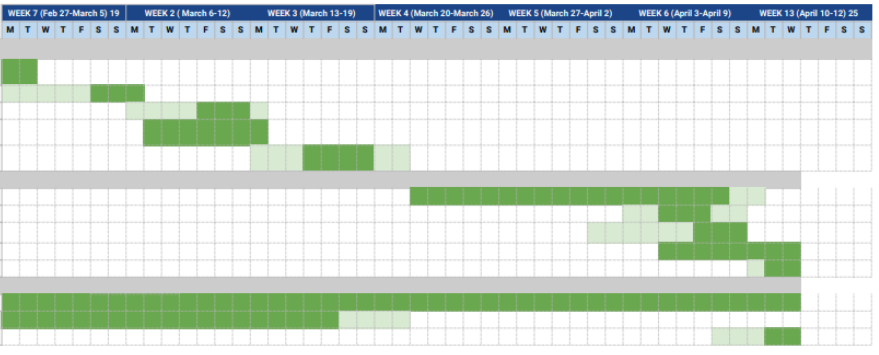


Design Project 4: Final Gantt Chart

Team Members Pranav, Kanglu, Ryan, Mariam **DATE** 2/27/23 - 4/12/23

Planned Timeline

TASK TITLE	START DATE	DUE DATE	DURATION
Milestones			
Milestone 0: Team Development and Project Planning	2/27/23	2/28/23	1
Milestone 1: Problem Definition	2/27/23	3/6/23	1
Milestone 2: Conceptual Design	3/6/23	3/13/23	3
Milestone 3: Preliminary Design (Design Review #1)	3/13/23	3/20/23	3
Milestone 4: Detail Design (Design Review 2)	3/20/23	3/26/23	6
Final Deliverables			
Medium Fidelity Prototype	1/30/23	2/27/23	29
Presentation Slide Deck	2/17/23	2/24/23	7
Oral Presentation	2/24/23	3/1/23	6
Design Project Report	2/20/23	3/5/23	14
Self and Peer Evaluation	3/3/23	3/5/23	3
Other			
Administrative Responsibilities	1/9/23	3/5/23	56
Conduct Individual Research	1/9/23	1/31/23	23
Practice for Design Expo Questions	2/27/23	3/3/23	5



Appendix B: Scheduled Weekly Meetings

Team 2

Milestone 0 and 1 Meeting

06 March 2023 / 12:30 PM / In class

ATTENDEES

- ~~Mariam~~
- ~~Pranav~~
- ~~Ryan~~

NOTES

- Cheryl has multiple sclerosis.
- Design a device that would fix her handwriting and make it easier/smoother.
- Focus on discreteness as the biggest factor for any design.

ACTION ITEMS

1. Weighed out pros and cons of choosing each client
2. Focused/ chose to work on Cheryl's problems
3. Brainstormed wrist bracelet for discreteness and flexibility/portability

NEXT WEEK'S AGENDA

- Research more about multiple sclerosis and common issues patients face
- Brainstorm ideas for next meeting for Cheryl's handwriting

Team 2

Milestone 2 Meeting

13 March 2023 / 12:30 PM / In class

ATTENDEES

- ~~Mariam~~
- ~~Pranav~~
- ~~Ryan~~

NOTES

- Ensure to create a case to hold the gyros and ensure smooth results
- Would magnets still be a feasible solution? Inquire with TA

ACTION ITEMS

1. Designed a very low fidelity prototype to showcase for TA
2. Start cadding proof of concept for ball bearing and bracelet
3. Brainstorm methods of gripping the pencil

NEXT WEEK'S AGENDA

- Brainstorm ideas for Cheryl
- Focus on discreteness for ideas
- Buy gyro balls- small diameter

Team 2

Milestone 3 Meeting

20 March 2023 / 12:30 PM / In class

ATTENDEES

- ~~Mariam~~
- ~~Pranav~~
- ~~Ryan~~

NOTES

- Consider other ideas instead of using a magnet
    - how would the magnet accommodate for taking it off easily as it would also need to be strong enough for proper grip
    - Think about using a shorter and wider pencil for best possible grip

ACTION ITEMS

1. Weighed out pros and cons of choosing each client
2. Focused/ chose to work on Cheryl's problems
3. Brainstormed wrist bracelet for discreteness and flexibility/portability

NEXT WEEK'S AGENDA

- Meet online for milestone completion
- Cad bracelet portion that will hold the gyros in place

- Think about ideas for strap - velcro or button system

Team 2

Milestone 4 Meeting

06 March 2023 / 12:30 PM / In class

ATTENDEES

- ~~Mariam~~
- ~~Pranav~~
- ~~Ryan~~

NOTES

- Consider making a customizable pencil
- Consider using fewer and larger gyros for the bottom of the wrist
- Consider bracelet sizing to ensure measurements accommodate Cheryl's situation

ACTION ITEMS

1. Cad the bracelet portion of the design - fix straps of each side
2. Prepare prototype for TA meeting
3. Print prototype of ball bearing to see areas needed for refinement
4. Ensure the prototype remains discreet yet efficient.

NEXT WEEK'S AGENDA

- Email Cheryl to inquire about her wrist size.
- Meeting online to complete milestone

- Consider buying gyros online instead of printing them

Team 2

Meeting 5

27 March 2023 / 12:30 PM / In person

ATTENDEES

- ~~Mariam~~
- ~~Pranav~~
- ~~Ryan~~

NOTES

- Focus on the wrist bracelet for the day and ensure to troubleshoot any problems to clear it up early on.
- Attempt printing one of the ball bearing covers to see if it works.
- Start looking into making either pencil gripper/ customizable pencil.

ACTION ITEMS

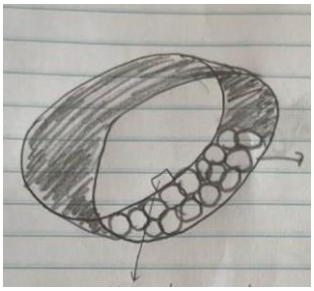
1. 3D-Print one of the ball bearing cases for one single ball to test out the prototype
2. Fix design and work with magnets for pencil
3. Prepare materials for bracelet design

NEXT WEEK'S AGENDA

- Brainstorm ideas for the pencil gripper and look into material selection

- Refine the cadding model to reprint for next week with proper measurements

Logbook:

Meeting	**Location**	**Date**	**Progress/ Discussion**
1	Online	10/04/2023	- Brainstorm methods that will help keep handwriting smooth - Must be discreet - Bracelet idea - Finish milestone and prepare ideas for the next meeting. - buy gyro balls from amazon Idea visual: 
2	ABB/Design Studio	17/04/2023	- cad model for wrist brace - start slideshow - 3D print caps for gyro balls - work on adjustable strap 

Appendix C: Comprehensive List of Sources

Pranav's Sources

Citation	Relevance
D. Severijns, I. Lamers, L. Lore Kerkhofs, and P. Feys, "Hand grip fatigability in persons with multiple sclerosis according to hand dominance and disease progression," *Journal of rehabilitation medicine*, Feb-2015. [Online]. Available: https://pubmed.ncbi.nlm.nih.gov/25268997/. [Accessed: 12-Apr-2023].	Provided information pertaining to the rate of loss of fine motor skills and the overall progression of the disease.
J. Flynt, "Optimizing the accuracy and tolerance of your 3D printer," *3D Insider*, 04-Jul-2020. [Online]. Available: https://3dinsider.com/3d-printing-accuracy/#:~:text=How%20important%20is%203D%20printer,much%20a%20best%2Dcase%20scenario. [Accessed: 12-Apr-2023].	Provided information regarding optimal settings and methods to follow to ensure appropriate dimensioning of CAD models. This was done to ensure optimal fitting of the steel balls into housing units.
MS Trust, "A study looking at the strength of hand grip in people with ms," *MS Trust*,	Provided informatio pertaining to the loss of grip strength and gripping abilities of MS patients.

2014. [Online]. Available: https://mstrust.org.uk/latest/research/a-study-looking-strength-hand-grip-people-ms#:~:text=Most%20of%20the%20people%20with,the%20device%20weakened%20over%20time. [Accessed: 12-Apr-2023].	
K. Kamogawa, T. Benhsain, S. Biyani, W. W. Campbell, R. J. Coleman, E. Hamada, and R. Hashimoto, "Useless hand syndrome: Diagnostic role of electromyography and nerve conduction studies," *Multiple Sclerosis and Related Disorders*, 22-Jan-2021. [Online]. Available: https://www.sciencedirect.com/science/article/abs/pii/S2211034821000584#:~:text=Useless%20hand%20syndrome%20(UHS)%20refers,patient%20with%20pre%2Dexisting%20MS. [Accessed: 12-Apr-2023].	Provided information about the specific regions of the hand that MS patients lose functionality in, and the most common order of loss of control.

Ryan's Sources

Citation	Relevance
A. Bisio, L. Pedullà, L. Bonzano, A. Tacchino, G. Brichetto, and M. Bove, "The kinematics of handwriting movements as expression of cognitive and sensorimotor impairments in people with multiple sclerosis," *Scientific Reports*, vol. 7, no. 1, 2017.	Provided Information on the progression of handwriting ability and movement for people that suffer from multiple sclerosis
P. Wellingham-Jones, "Characteristics of handwriting of subjects with multiple sclerosis," *Perceptual and Motor Skills*, vol.	Provided insight into the attributes related to handwriting with multiple sclerosis along with visual examples and demographic sizes as well

73, no. 3, pp. 867–879, 1991.	
M. McMillin, “Hand tools and tips for better dexterity with MS ,” *healthcentral.com*. [Online]. Available: https://www.healthcentral.com/slideshow/ms-hand-tools-and-tips-to-improve-dexterity. [Accessed: 13-Apr-2023].	Provided information regarding the processes and lifestyle additions that can help aid people suffering from MS in terms of coordination

Mariam’s Sources

Citations	Relevance
T. Schenk, E. U. Walther, and N. Mai, “Closed- and open-loop handwriting performance in patients with multiple sclerosis,” *European Journal of Neurology*, vol. 7, no. 3, pp. 269–279, 2000.	Provided information on the differences in motor control performance and gave insight into the handwriting ability of patients with multiple sclerosis
S. D. Newsome, G. von Geldern, H. Shou, M. Baynes, R. E. R. Marasigan, P. A. Calabresi, and K. M. Zackowski, “Longitudinal assessment of hand function in individuals with multiple sclerosis,” *Multiple Sclerosis and Related Disorders*, vol. 32, pp. 107–113, 2019.	Provided a long term insight into how hand function of people with MS progresses over time
M.-C. Tsai and S.-C. Huang, “Analysis of the Biomechanics of the Fingers in Different Writing Stances .” Pennsylvania State University., 2013.	Provided information pertaining to different handwriting postures/stances, to assist in planning the functionality of the device.

Appendix D: Additional Documentation

Appendix E: Design Studio Worksheets

Milestone 1 – Cover Page

Team Number: 2

Please list full names and MacID's of all *present* Team Members.

Full Name:	MacID:
Pranav Chandrakumar	chandp19
Ryan Junejo	Junejr2
Mariam Mohamed	moham68
Kanglu Liu	Liu1385

Any student that is ***not*** present for Design Studio will not be given credit for completion of the worksheet and may be subject to a 10% deduction to their DP-4 grade.

MILESTONE 1 (STAGE 1) – CLIENT VISIT QUESTIONS WORKSHEET

Team Number: 2

As a team, prepare a preliminary **list of questions** to ask your client. Enter questions in the space below.

Preliminary List of Questions:

Questions are for Cheryl only, as our group was unable to directly ask David questions, due to his cancellation on Thursday, and our busy schedules on Friday as we were wrapping up DP3.

- If you could pick out ONE single thing in your day that is made more difficult due to your MS, what would it be?
- What are some of the limitations of your Bioness, be that just comfort or mobility limitations?
- How has your disease progressed, and what is the current estimate on further loss of motion?
- What advice would you give to someone getting used to a Bioness for the first time?
-

Document any questions that come up *during* the client visit in the space below.

Additional Questions:

- How is your Bioness device recharged?
- Can a portable battery pack solve your issue of portable charging?
- Do you have any difficulty during the winter putting on winter boots?
- What is your biggest challenge with taking care of your grandkids?

MILESTONE 1 (STAGE 2) – DOCUMENTATION OF DISCUSSION

Team Number: 2

As a team, document your discussions with the client during their visit.

If you could pick out ONE single thing in your day that is made more difficult due to your MS, what would it be?

- Due to her limited hand mobility, handwriting has become quite difficult for her.

What are some of the limitations of your Bioness, be that just comfort or mobility limitations?

- One of the greatest limitations of Cheryl's Bioness is the nightly charging that's required, as well as the replacement of the electrodes mandated by the manufacturer. This consistent recharging prevents her from partaking in some leisurely activities from before her diagnosis, such as camping trips.

How is your Bioness device recharged?

- The Bioness is recharged through a simple 3-pronged wall connection, at night.

Can a portable battery pack solve your issue of portable charging?

- Potentially, although she has not explored this option yet.

Do you have any difficulty during the winter putting on winter boots?

- The bulkiness of the Bioness device prevents her from any type of winter boot. She instead has to use a specific type of boot which accommodates the extra size of the device.

What advice would you give to someone getting used to A Bioness for the first time?

- Cheryl recommended that a person getting used to a Bioness should prioritize getting comfortable with the device and avoid over exerting themselves in activities.

MILESTONE 1 (STAGE 3) – CUSTOMER REQUIREMENTS

Team Number: 2

As a team, develop a list of customer requirements that detail what the proposed solution should do and achieve. For each requirement, categorize in parentheses as an objective, constraint or function. As a reminder, requirements ***can be*** *more than one* of the three.

List your customer requirements in this field. Bullet-point format is acceptable. Requirements can be written as either a brief sentence or 2-4 words, whichever is most appropriate. For each requirement, indicate (in parentheses) whether it is an objective, function, or constraint.

- Must improve her quality of life imposed by her MS (objective)
- Should improve her ability for physical motion with the limbs affected by her MS (function)
- Should not exceed the physical size of her previously used device (constraint)
- Should not hinder her day to day activities (objective)
- should be less susceptible to drastic changes in weather (objective)

MILESTONE 1 (STAGE 4) – NEED STATEMENT

Team Number: 2

Write your Need Statement in the space below. Recall that your need statement should:

→ Have a clearly defined problem (what is the need?)

→ Indicate your client (who has the need?)

→ Have a clearly defined outcome (what do you hope to solve and why is it important?)

NEED STATEMENT:	Design a wearable, compact device which increases Cheryl's quality of life by improving mobility with her hands, easing her day-to-day activities. This device will limit the negative implications imposed upon her due to her MS, while retaining discretion and functionality.

Milestone 0 – Cover Page

Team Number: 02

Please list full names and MacID's of all *present* Team Members.

Full Name:	MacID:
Ryan Junejo	junejr2
Kanglu Liu	liu1385
Pranav Chandrakumar	chandp19
Mariam Mohamed	moham68

Any student that is ***not*** present for Design Studio will not be given credit for completion of the worksheet and may be subject to a 10% deduction to their DP-3 grade.

Please attach your Team Portrait in the dialog box below.

MILESTONE 0 – TEAM CHARTER

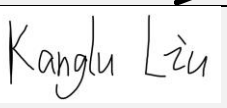
Team Number: 02

***Incoming Personnel Administrative Portfolio**:* Prior to identifying **Project Leads**, identify each team members incoming experience from previous design projects.

	Team Member Name:	**Project Leads**
1.	Ryan Junejo	☐M ☒A ☐C ☐S
2.	Pranav Chandrakumar	☒M ☐A ☐C ☐S
3.	Mariam Mohamed	☐M ☐A ☐C ☒S
4.	Kanglu Liu	☐M ☐A ☒C ☐S

To 'check' each box in the Project Leads column, you must have this document open in the Microsoft Word Desktop App (not the browser and not MS Teams).

***Project Leads**: As a team*, come to an agreement on who will take the lead on each administrative task. Each role can only have one team member. In the event there are 3 students in a team, there will be no Subject Matter Expert

Role:	**Team Member Name:**	**MacID & Signature**
Manager	Pranav Chandrakumar	chandp19 
Administrator	Ryan Junejo	Junejr2 
Coordinator	Kanglu Liu	liu1385 
Subject Matter Expert	Mariam Mohamed	moham68 

Milestone 2 – Cover Page

Team Number: 2

Please list full names and MacID's of all *present* Team Members

Full Name:	MacID:
Mariam Mohamed	moham68
Pranav Chandrakumar	chandp19
Ryan Junejo	Junejr2

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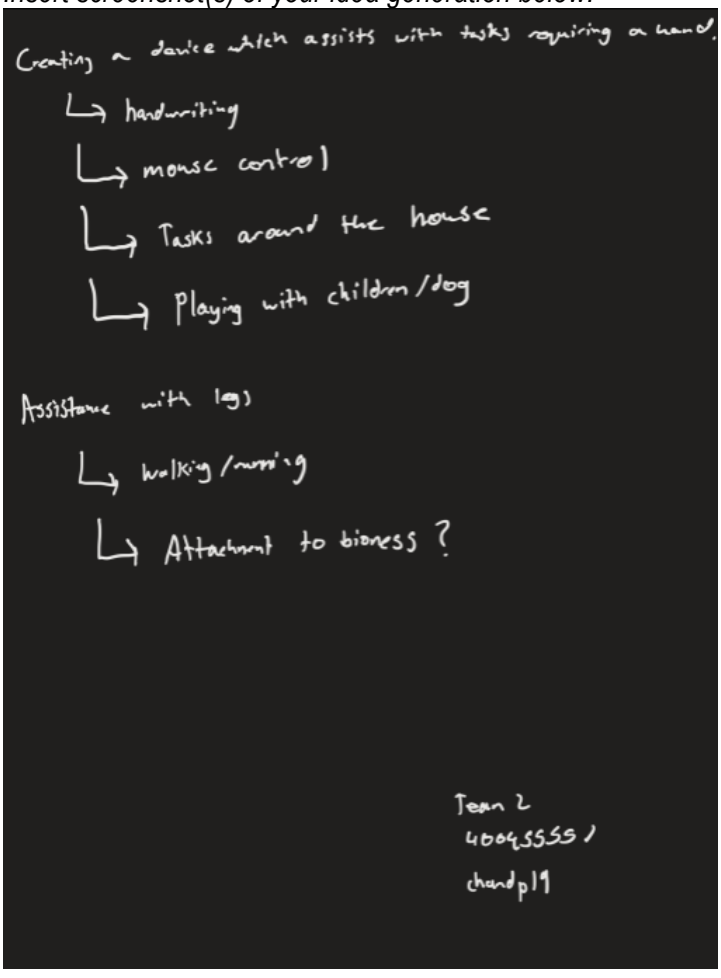
MILESTONE 2 (STAGE 1) – IDEA GENERATION

Team Number: 2

1. As a team, outline several potential concepts.
   → Your ideas can be sketches are bullet-point descriptions.
   → Be creative with the materials you choose and the modifications you propose.
   → Be sure to clearly write your Team Number, Name and MacID.
2. Take a photo of your work.
3. Insert your photo as a Picture (Insert > Picture > This Device).
4. **Do not include more than one sketch per page.**

Insert screenshot(s) of your idea generation below.



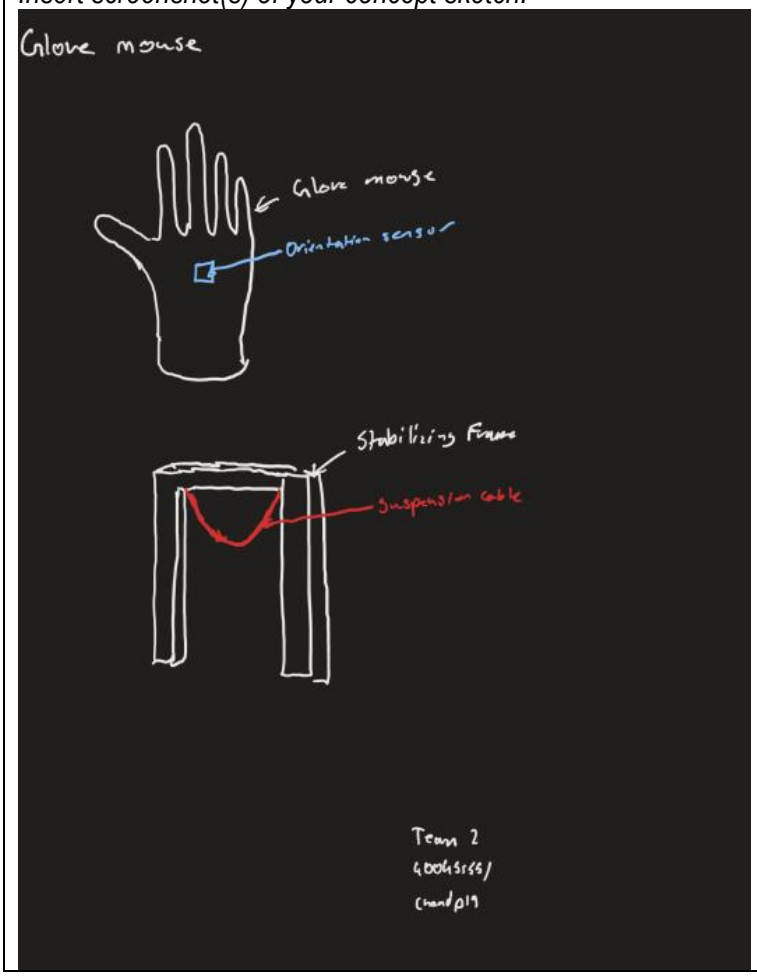
*** Copy-and-paste the above if there is more than one photo

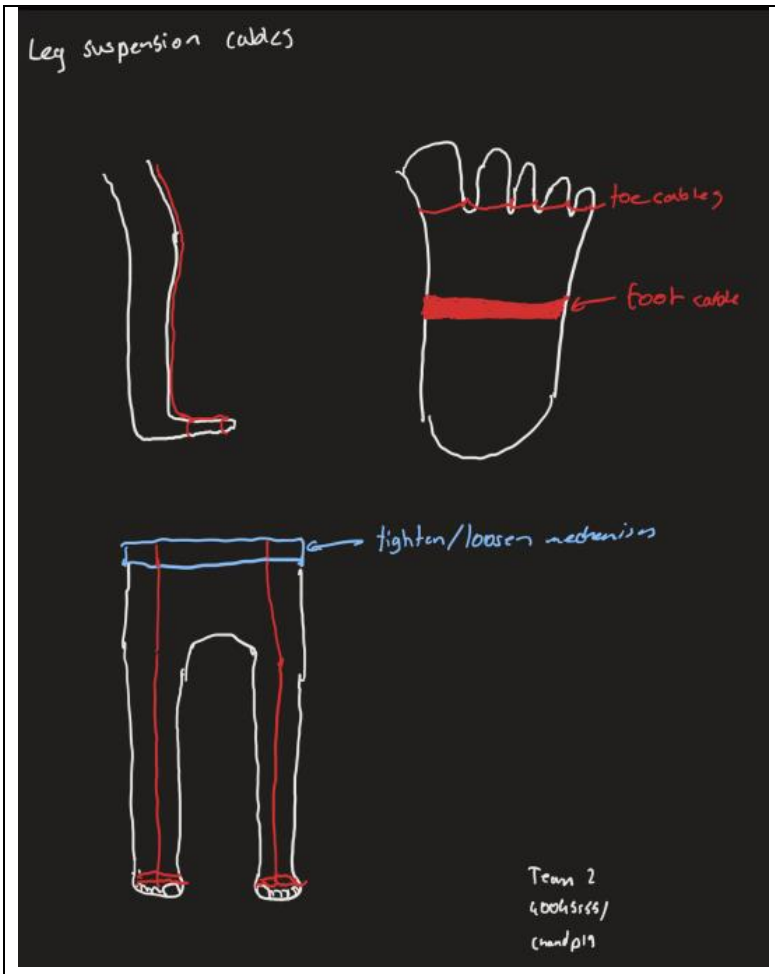
MILESTONE 2 (STAGE 2) – CONCEPT SKETCHES

Team Number: 2

1. Complete your sketch on a separate sheet of paper or a whiteboard.
   → Be sure to clearly write your Team Number, Name and MacID.
2. Take a photo of your work.
3. Insert your photo as a Picture (Insert > Picture > This Device).
4. **Do not include more than one sketch per page.**

Insert screenshot(s) of your concept sketch.




Leg suspension cables
toe cables
foot cable
tighten/loosen mechanism
Team 2

Micro Wheel guided leg junejr2

Wheels attached to the fibrous muscle of the clients leg in order to facilitate easier raising and lowering of her calf muscles

This will help her walk/run

Wheels can be speed controlled and customized

pros
Discreet
Can help her play games like soccer

Cons
.) Can damage leg muscle

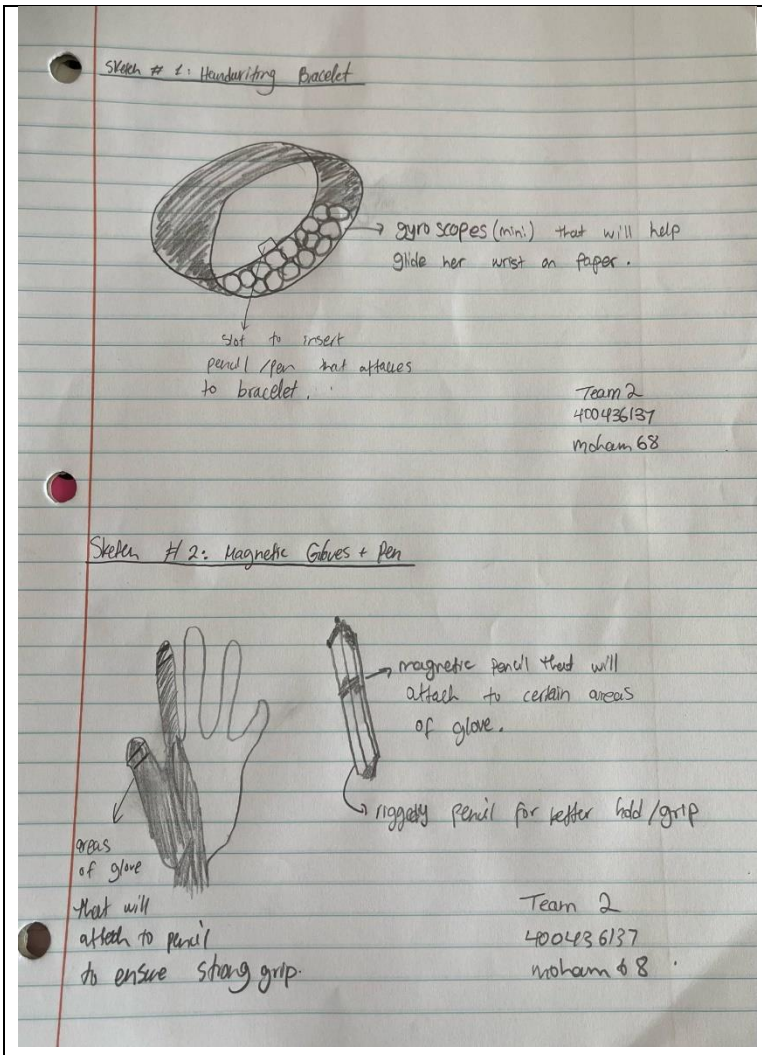
Hand Metal Brace

.) Covered in skin color plastic to ensure transparency
.) Automatic guiding motion
.) Electrically conductive

Pros
Writing support
can be discreet

Cons
.) might be heavy
.) Hinders hand
.) Needs getting used to

junejr2



*** Copy-and-paste the above if there is more than one photo

MILESTONE 2 (STAGE 3) – CONCEPT EVALUATION

Team Number: 2

1. As a team, evaluate your concept solutions in the table below.
   → List your Criteria in the first column.
   - You should include a minimum of 5 criteria.

   → Fill out the table below, comparing your designs against a baseline concept (the decision of a baseline concept is arbitrary and entirely up to your team to decide).
   - Replace "Concept 1", "Concept 2", etc. with more descriptive labels (e.g., a distinguishing feature or the name of student author).
   - Indicate a "+" if a concept is better than the baseline, a "–" if a concept is worse, or a "S" if a concept is the same.

	Glove Mouse	***Foot Suspension***	***Handwriting Bracelet***	***Magnetic Glove + Pen***	***Micro Wheel Guided Brace***	***Metallic Hand Brace***		
Viability	+	+	+	-	-	+		
Ease of Creation	-	-	S	+	-	-		
Discreetness	-	+	+	-	-	-		
Cost Efficiency	S	S	+	+	S	-		
Demographic Size	+	S	S	S	+	+		
Market Alternatives	S	-	-	S	+	-		
Material Requirements	+	-	+	+	-	+		
Total +	3	2	4	3	2	3		
Total –	2	3	1	2	4	4		
Total Score	1	-1	3	1	-2	-1		

** The above table represents a Pugh Matrix, a simple tool for evaluating different design solutions against a set number of criteria. You are not *required* to use this exact tool for evaluating your concepts and are free to choose others you feel are more appropriate. **Just be sure to *document* your process for assessment later*****.

*** As part of the design project report, you will be expected to include a ***Summary of the Design Process*** section, documenting the progression of your design. This will be evaluated as part of **medium-fidelity prototype**. The purpose here is to consider both your final design and decisions that led to your final design.

2. Indicate the concept(s) you have selected to pursue for further development and testing, include **justification.**

Concepts selected: Handwriting Bracelet (concept 3) and Magnetic Glove + Pen (concept 4)

We have decided to focus on Cheryl's handwriting dilemma while also considering important factors such as discreetness and accessibility. The design of the bracelet would be extremely discreet while even serving as a fashion item as the device itself is housed in the bracelet. The bracelet would have mini gyro balls attached to the bottom of it to allow for the wrist to glide easily with hand movement to ensure higher handwriting quality as it would be smooth and effective. As for pen/pencil grip, we have decided to merge concept 3 with the magnetic glove + pen design (concept 4), as that design will assist in grip strength, which is an integral facet of handwriting assistive devices. Although the glove may limit discreetness, it's possible to adapt the device to fit a smaller form factor

*** **It's perfectly acceptable to consider more than one design at this point.**

3. Briefly describe any **design refinements** that your team will consider for the selected concept. Design refinements include any changes or modifications that deviate from the initial design. These changes or modifications may be based on *other* designs that were proposed but not selected, or they may be derived from discussions during your team's concept evaluation.

- Pencil/Pen grip will be achieved via integration with the magnetic grip design.
- Material selection for all components needs to be further refined.
- Retaining discreetness is an important consideration for all device components, especially for the magnetic glove grip.
- Form factor needs to be more thoroughly discussed in regards to how the glove will be customized to Cheryl's specific form
-

Milestone 3 – Cover Page

Team Number: 2

Please list full names and MacID's of all *present* Team Members

Full Name:	MacID:
Mariam Mohamed	moham68
Pranav Chandrakumar	chandp19
Ryan Junejo	Junejr2

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Milestone 3 (Stage 2) – Design review #1 Feedback

Team Number: 2

Use the space below to document mentor feedback for your design.
- Overall design seems well put together, especially the bracelet/gyro component. - Magnets will assist with grip strength, but may cause issues as they will repel one another, resulting in muscle discomfort. - Gyro to assist in movement seems plausible, - Design was well made, does not need to be more complex

Use the space below to propose design refinements based on the feedback.
- Replacing the magnets for grip assistance with a specialized pen/pencil that assists with grip strength. - Instead of using one single gyro, utilize multiple miniaturized ball bearings. - Word on modelling the mini gyroscopes and finding material for an adjustable bracelet. - Maybe incorporate a clasp for the bracelet. - Try to ensure that the bracelet remains adjustable, to fit different wrist sizes.

Milestone 4 – Cover Page

Team Number: 02

Please list full names and MacID's of all *present* Team Members

Full Name:	MacID:
Ryan Junejo	Junejr2
Mariam Mohamed	moham68
Pranav Chandrakumar	chandp19

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MILESTONE 4 (STAGE 2) – DESIGN REVIEW #2 FEEDBACK

Team Number: 02

Use the space below to document mentor feedback for your design.

- Think about alternative methods for the ball bearings instead of 3D-printing if the process is easier.
- In order to develop the medium fidelity prototype, ensure that the final device caters specifically to Cheryl's needs.
- Think about how comfortable the magnets of the finger gloves would be for Cheryl.
- Figure out Cheryl's wrist size to ensure design meets her needs.
- Decide material selection for finger gloves and wrist bracelet.
- Ensure that the bracelet is shaped in a way that accounts for her wrist shape/size.

Use the space below to propose design refinements based on the feedback.

- Consider using 3 or more balls/marbles with their own specific placements instead of a big set of balls for the gyro.
- Model a ball bearing system accustomed to Cheryl's wrist size.
- Refine the pencil/pen gripping component (determine how magnets will interact with the patient).
- Consider making a custom pen/pencil to attach to finger glove, or a slip-on piece that attaches to the pen/pencil
- Perhaps consider using an adhesive instead of a magnet for the gripping component of the device (not likely to be done, should be treated as a last resort)