

GNG 2101 Project Report
User and Product Manual

LightShield
Dynamically Polarizing Glasses Project

Submitted by

GNG 2101 - Lab C 02, Group 2.4

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List of Acronyms and Glossary

Table 1. Acronyms

Acronym	Definition
CAD	Canadian Dollar
QTY	quantity
UPM	User and Product Manual
BOM	Bill of Material

Table 2. Glossary

Term	Acronym	Definition
Lightshield	NA	The name of the product— dynamically polarizing glasses

1 Introduction

Lightshield is a solution that enables those with severe light sensitivity to transition from many pairs of tinted glasses to a single pair via the use of a lightweight, wearable device that can be adjusted automatically or manually. Unlike comparable products on the market that can only be changed manually or through a mobile phone application, Lightshield allows for manual adjustment of the appropriate light *interval*. Meanwhile, due to the photoresistor put on the front of the glasses, the glasses may be automatically adjusted to the light environment within the user's predetermined *interval*. The issue is that the photoresistor detects just the brightness directly in front of the user, not the ambient light. As a result, the brightness of glasses is sometimes low even when the room is quite dark, which is an issue that this product has not yet resolved. This paper is intended to guide customers of various categories, such as those with light sensitivity or photophobia, as well as drivers who need to drive for an extended period of time, about the effectiveness of our product and how to properly utilise this pair of glasses. Additionally, this paper will provide several technical tests and explanations to assist future students design better iterative products.

2 Overview

Lightshield was designed to help people with light sensitivity or photophobia. As it stands, bright light in the environment can cause pain and discomfort for people with light sensitivity and they typically use multiple pairs of sunglasses with increasing darkness to help them feel comfortable. This is inconvenient since people need to carry around various sunglasses and it takes time to wear and store the glasses. To design a better solution, some core requirements have been identified. Notably, the glasses need to have lenses with variable tint, which must automatically adjust to the ambient light conditions. Also, the dynamically polarizing glasses must enclose the eyes to let in as little light as possible. The polarizing glasses must respond quickly to different light levels as well. Lightshield is better than other products (eg. Ampere Sunglasses) because Ampere's product is a manual adjustment and does not enclose the eyes. In addition, Lightshield has a faster response time (< 1 ms).

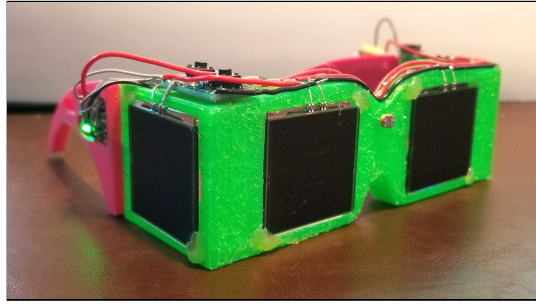


Figure 1. Lightshild final version

Lightshield's frame is made of PLA material while the user access mode is a button on the microcontroller. Lightshield offers 9 hours of battery life, 30 minutes of recharge time and 65% - 95% tint.

2.1 Conventions

On the top right side of the glasses, the user can control the tint interval with a button. The button can control whether the lenses get lighter or brighter.

2.2 Cautions & Warnings

The user should avoid dropping the glasses in a sink of water or in other circumstances since the electronics can be damaged. A 5V charger must be used for charging.

3 Getting started

3.1 Configuration Considerations

The following figure depicts all of the core components of the glasses. The important inputs to be aware of are the power switch, LiPo charging port, and the input buttons. The power switch is used to turn the system on and off. The LiPo charging port is a micro-usb port that allows the user to charge the built-in battery. The input buttons on the top of the frame allow the user to manually adjust the tint.

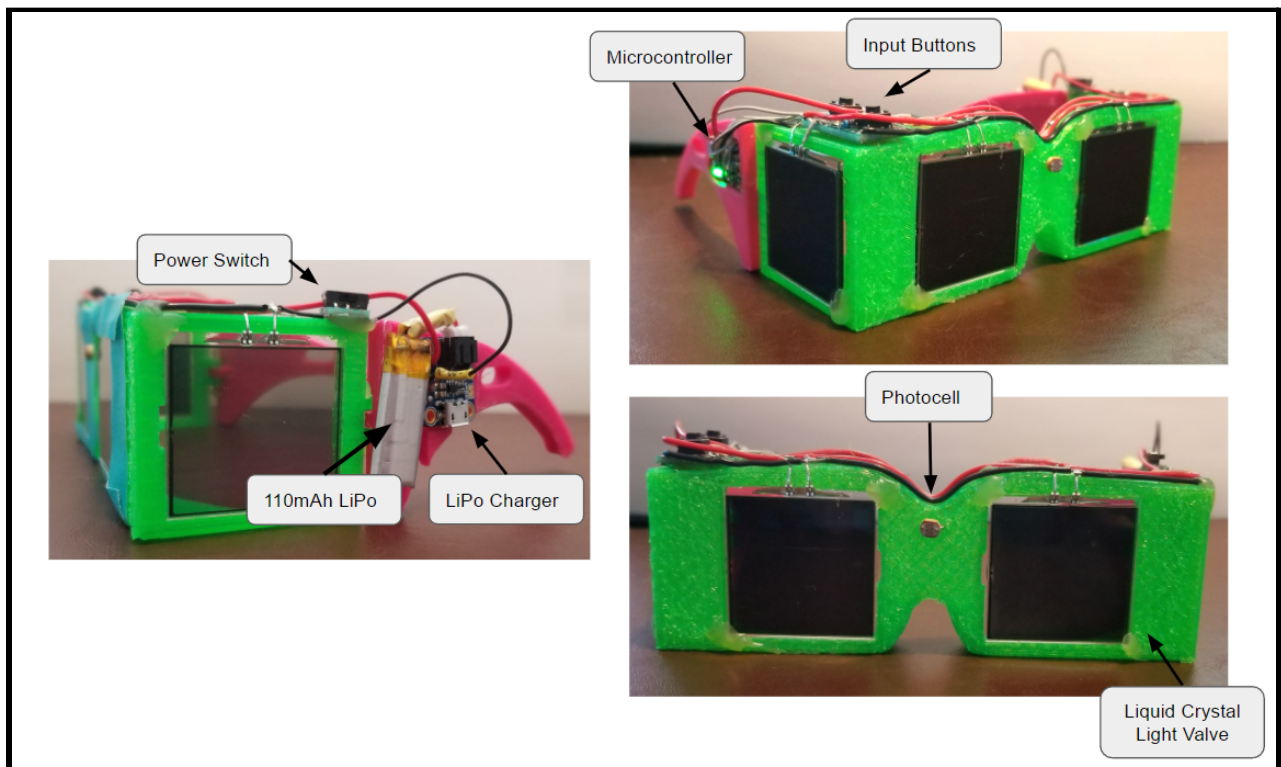


Figure 2. core components of the final version

3.2 User Access Considerations

All users will use the glasses the same way. They will place the glasses on their face and then let the system automatically adjust to the ambient light or they can use the buttons to make manual adjustment.

3.3 Accessing/setting-up the System

To turn on the system, the user must put the power switch to the “ON” position. The system will then start up and begin adjusting the lens tint in response to the ambient light conditions.

3.4 System Organization & Navigation

Once the system is powered on, the user can interact with lens tint by manipulating the input buttons. The front button will make the lens darker and the back button will make the lens lighter.

3.5 Exiting the System

There is a power switch on the frame of the glasses that let you turn off the system. This will help conserve energy.

4 Using the System

4.1 Given Function and Feature

There are two types of control system: power switch and adjustment control button.

Power switch is on the top of the left peripheral lens. When you turn it to the left, the system is on. Control system is on the top of the left peripheral lens. There are two buttons, the one on the left is “+” which means to increase the tint level, and the other is “-” which means decrease.

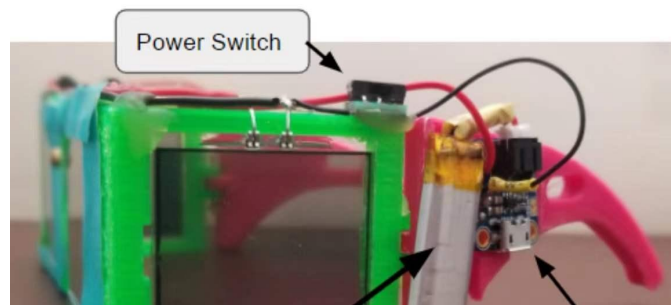


Figure 3. power switch of the final version

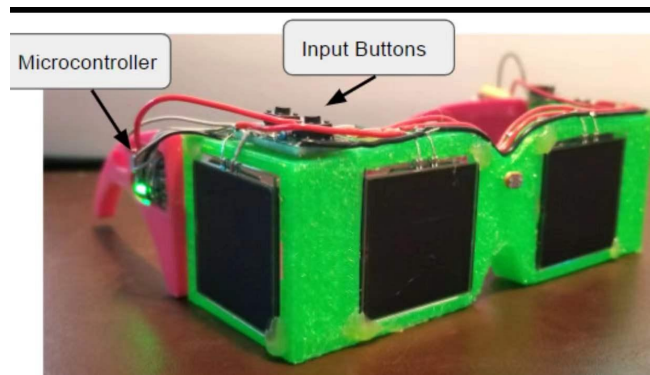


Figure 4. microcontroller and input buttons of the final version

5 Troubleshooting & Support

5.1 Error Messages or Behaviors

Low Battery

When the battery becomes depleted, a bright pink light on the microcontroller will illuminate. This indicates that the battery must be recharged.

Lithium Battery Degradation

Overtime, the battery's capacity will naturally decrease. Rechargeable Lithium Ion batteries are only rated for a finite number of charge/recharge cycles. The user might notice that the battery life is lower than it was when the system was brand new.

5.2 Special Considerations

If the battery needs to be replaced, it should be replaced with an Adafruit-branded 110mAH Lithium Ion Polymer battery. It is important that the battery be Adafruit-branded in order to ensure that it is compatible with the system.

5.3 Maintenance

The built-in battery should be recharged via the micro-usb port when the battery is depleted.

5.4 Support

Please contact the Lightshield creators for assistance:

- klorb014@uottawa.ca
- dwang136@uottawa.ca
- zwen051@uottawa.ca
- avyever@gmail.com

6 Product Documentation

6.1.1 BOM

Table 3. Bill of materials

Type	Vendor	Description/Dimensions	Price (CAD)	QTY.	TOTAL	Link
Controllable Shutter Glass	Elmwood Electronics	A Liquid Crystal Light Valve (a.k.a a LCD Controllable Black-out Panel; LCD size: 31 x 33 x 2 mm; Dimensions: 36 x 36 mm ; Driving voltage: 3-5V)	\$4.99	4	\$19.96	Link 1
Microcontroller, Adafruit Trinket M0	Elmwood Electronics	The Adafruit Trinket M0 is a tiny microcontroller board: 27mm x 15.3mm x 2.75mm / 1.07" x 0.6" x 0.1"; Height with MicroUSB: 3.5mm / 0.14"; Weight: 1.4g	\$12.99	1	\$12.99	Link 2
PLA Glasses Frame	UOttawa 3D printer	3D printable plastic	\$0.00	1	\$0.00	Link 4
Tactile Switch Buttons	Elmwood Electronics	Medium-sized clicky momentary switches are standard input "buttons" on electronic projects; The pins are normally open (disconnected) and when the button is pressed they are momentarily closed.	\$3.99	1	\$3.99	Link 5
USB LIION/LIPOLY CHARGER	Elmwood Electronics	The charge current is 100mA by default, and it can be easily changed over to 500mA mode by soldering closed the jumper on the front, for when you'll only be charging batteries with 500mAh size or larger.	\$9.99	1	\$9.99	Link 6
Lithium Ion Polymer Battery	Elmwood Electronics	3.7V 110MAH	\$9.99	1	\$9.99	Link 7
Total product cost (without taxes and shipping)					\$56.92	
Total product cost (including taxes and shipping)					\$64.32	

6.1.2 Equipment list

- 1 x computer with access to SolidWorks, Ultimaker Cura, and Arduino
- 1 x 3D printer
- Electronics and soldering equipment including:
 - 1 x soldering iron
 - 1 x desoldering pump
 - 1 x Scissors
 - lead-free solder
 - at least 4x 5cm hook-up wires

6.1.3 Instructions

After deciding on a subsystem, the most critical step is to verify that the necessary materials and equipment are available, followed by the creation of the necessary electrical schematic and software flow diagram.

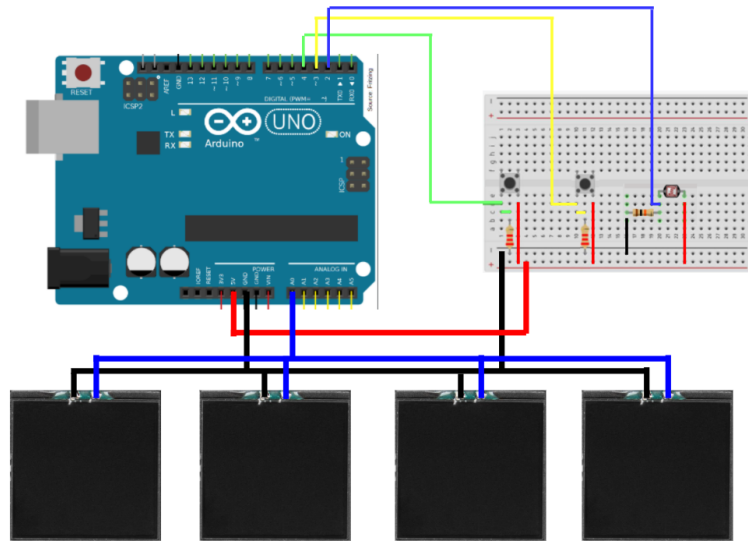


Figure 5. Electrical schematic for updated design of the first prototype

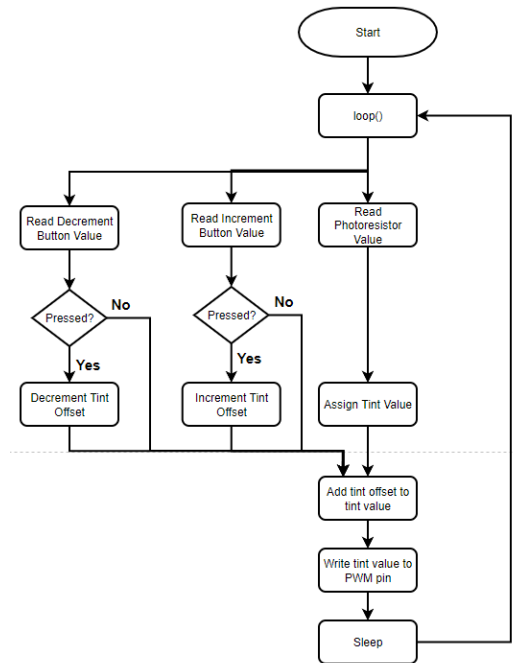


Figure 6. Software flow diagram for updated design of the first prototype

The First Prototype can then adjust the light through the lens by manually [placing a button](#). Since this is the original prototype, it will look pretty rough and huge, with no discernible sunglasses shape. A 3D printer was needed to create a second prototype. It can use the ideal sketch below to construct and print its frame and legs.

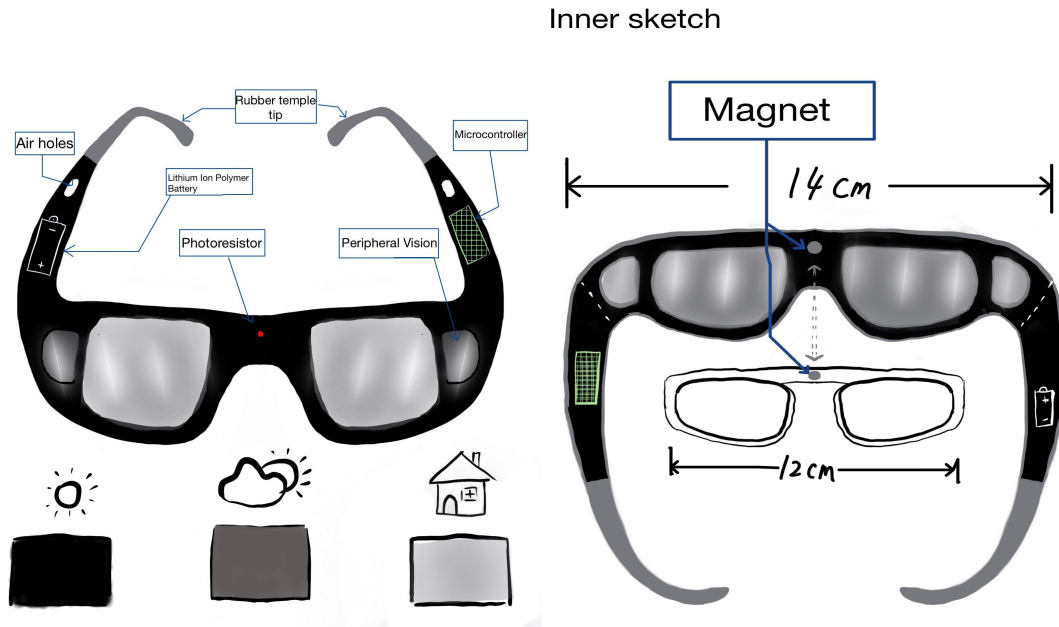


Figure 7. The sketches of the sunglasses

Prototype 2 is unquestionably a significant advancement. To begin, the product has a basic eyeglass shape, and after updating the electrical schematic and software flow diagram, it may be altered manually or automatically within specified boundaries. However, the second prototype is still rather enormous, with a series of minor faults indicating that its dimensions do not correspond to those of the client.

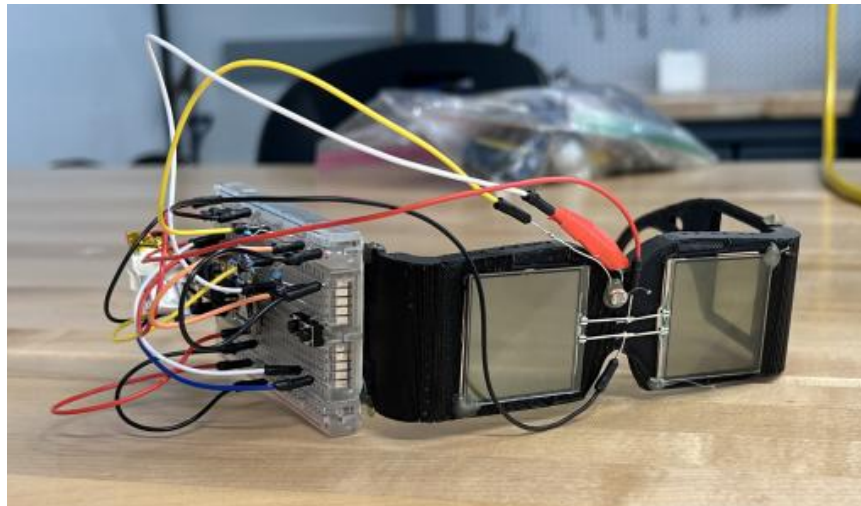


Figure 8: Finished prototype II

Eventually, after successfully updating the Software Flow diagram and 3D printed schematic and simplifying it, our final version achieved the desired result: It may be adjusted [manually](#) or [automatically](#), and the glasses can be adjusted automatically to the light environment within the user's set interval.

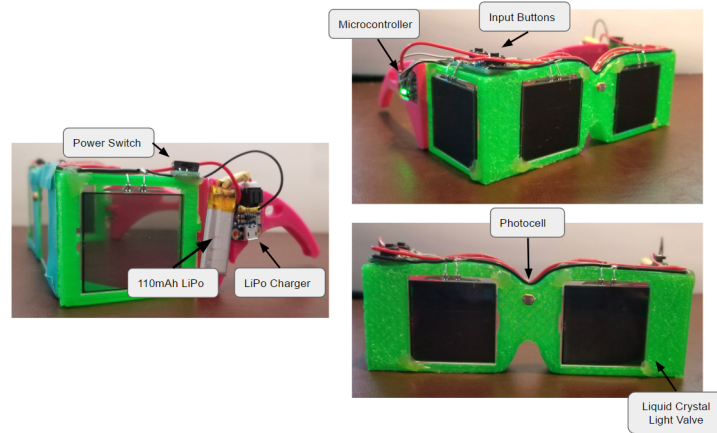


Figure 2. core components of the final version

6.2 Testing & Validation

Battery Life Testing:

To validate the battery life of the system, the lithium ion polymer battery was fully charged and then connected to the system. The time required to deplete the battery was measured in order to assess the battery life. The following table shows the results.

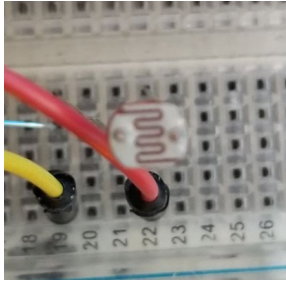
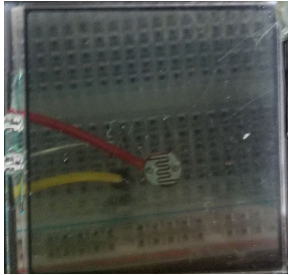

Table: Battery life test results

	Battery Life (Hours)
Test 1	9.05
Test 2	9.05
Test 3	8.98
Average	9.03

Visual Light Transmission Test

The next test was designed to measure the visual light transmitted through the lenses when they are most tinted and least tinted. The test uses a photocell placed against the lens to measure the light intensity. This test found that the maximum light transmission of the lens was 36.6% and the minimum light transmission was 9.4%.

Table : Visual light transmission (VLT) test results

	Control	Maximum VLT	Minimum VLT
Qualitative Observation			
Raw Sensor Data	Analog reading = 213 Analog reading = 213 Analog reading = 213 Analog reading = 213 Analog reading = 213	Analog reading = 78 Analog reading = 79 Analog reading = 78 Analog reading = 78 Analog reading = 78	Analog reading = 20 Analog reading = 20 Analog reading = 20 Analog reading = 20 Analog reading = 20
VLT (%)	100%	36.6%	9.4%

7 Conclusions and Recommendations for Future Work

7.1 Lessons Learned / What were abandoned

In this GNG 2101 project, our group learned the design process (Empathize, Define, Ideate, Prototype, Test) and how to execute it. We listed the client needs and the specifications for the prototype. Next, we turned the concept from paper to reality (actual device) by using the Ultimaker along with a microcontroller and a battery. Correspondingly, testing the prototype was carried out. In addition, we learned to plan better as a team if a group member requests someone else to 3D print on campus. That is because time should be accounted for when the USB / SD card

cannot be read at the MakerSpace, or that machines are being in-use or that the 3D file must be in STL format before printing.

For this project, the aesthetics of the glasses was abandoned due to time constraint.

7.2 Recommendations and Possible Improvements

If we had a few more months to work on this project, our group would polish the design and keep iterating on the frame design until it is comfortable for the client. Perhaps, sanding the sharp edges would be useful too. The frame also needs to seal the face better. Based on the client's feedback, the spacing between the lenses can be narrowed while the nosepiece can be re-designed again. The glasses sat too high on her face / nose, which requires further iteration of the glasses. A round corner could be considered too. *In terms of the lenses' size, customization would be a favourable enhancement to fill up the space in the frame. As such, finding a manufacturer that meets this requirement would be the next step.* Moreover, the electronics can be improved by creating a custom PCB. On another note, the polarizing glasses could be designed to be waterproof and withstand rain, snow or winter conditions. Finally, the client suggested that the device could include a low power mode to extend the battery life.

7.3 Conclusion

To sum up, the final prototype lens's dimming/lightening and weight distribution fulfilled client requirements, and it is more organized due to the tucked-in wires.

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What do sunglass categories mean? Sunglasses For Sport. (2021, September 16). Retrieved January 30, 2022, from <https://www.sunglassesforsport.com/2014/09/25/what-do-sunglass-categories-mean/>

APPENDICES

8 APPENDIX I: Design Files

Table 4. Referenced Documents

Document Name	Document Location and/or URL	Issuance Date
LightShield C24-Makerepo	https://makerepo.com/Klorb014/1121.lightshield-c24	2022/03/14
Project Deliverable B: Needs, Problem Statement, Metrics, Benchmarking and Target Specifications	https://docs.google.com/document/d/1zhm3N17yqkb2V39JhlWZkSC-bnQTBFX5qBCiSCMNrfs/edit?usp=sharing	2022/01/23
Project Deliverable C: Conceptual Design and Project Plan	https://docs.google.com/document/d/1ARpq6197CG9_HSKmqTY5GMMUnIKf5kl3FF5cWx1qYsE/edit?usp=sharing	2022/01/30
Project Deliverable D: Detailed Design, Prototype 1, BOM, PeerFeedback and Team Dynamics	https://docs.google.com/document/d/1bUFPCugpwYR93BaL60DjOv3j2k9qXenR2J08-6SP ECU/edit?usp=sharing	2022/02/06
12	https://docs.google.com/spreadsheets/d/1vI3iLzc493BqDHmvYJghMfVyCw9IZ1akWQCSO07N2-A/edit?usp=sharing	2022/02/06
Project Deliverable F: Prototype 2	https://docs.google.com/document/d/1w1vcKu8Z9phvfDaFgvbNp4PVYT-9Tl-pgwJ5EtGt0uM/edit?usp=sharing	2022/03/06
Project Deliverable G: Business Model and Economics Report	https://docs.google.com/document/d/1GNhr9gUuLcqHvbuqZ0O_V2qfnq9MTHme_ukDBwsESdU/edit?usp=sharing	2022/03/20

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