Illuminate Me Project Name:_____Per:_____

Scenario: Bikers in Portland, Oregon and many other locations are being hit and even killed due to not being seen by motor vehicles. Bikers on country roads are having the same problem. Help solve this problem by engineering brightly lit clothing that will be powered by rechargeable batteries, which are charged by solar! Flexible solar panels can be attached to bike helmets in order to charge battery packs for a renewable energy source.

Design Challenge: Working as a clothing designer, you will design a garment to be worn while biking (or possibly boarding or skiing) that will light up 1-2 with very bright LEDs called NeoPixels. This needs to be a creative design that people will enjoy wearing out in public. You need to incorporate 1-2 places where the LEDs can be attached and an area for the programmable circuit board (FLORA). In order to be a good steward of the environment, you will also need to charge the battery pack with a flexible solar panel attached to a bike (boarding, skiing) helmet.

Explore/Investigate:
Watch the videos presented about bike safety.

Explore garment making. If possible, visit a clothing factory.
If that's not possible watch a few videos on clothing on the Internet.

Criteria: All garments must have the following.

- A *large* outline design (picture) that people would wear out in public.
- Be colorful.
- Have at least one place for the bright flashing NeoPixel (LED) in order to attract attention of drivers.
- Have a location for the FLORA (programmable circuit board) that blends into the design.
- Connect to the solar panel on bike helmet and battery pack or have a place for the battery pack.
- Be uniquely programmed to flash the NeoPixel (LEDs).

Constraints: You must use only the materials provided unless discussed with your instructor and you get prior approval. Your garment must be wearable.

Materials List: You will receive the following materials to design your wearable project.

Hardware:

- 1-Adafruit's FLORA-Wearable microprocessor, Arduino-compatible
- 1 to 2-Adafruit's FLORA RGB Smart NeoPixels

- Variety of flexible solar panels
- 3x AAA Battery Holder with on/off switch and 2-Pin JST
- 3x AAA 1000 mAh rechargeable batteries
- Connecting wires, 14 gauge
- Computer with Arduino software installed

Other Materials:

- 1-Garment (Example: T-Shirt) *you will need to provide*
- 1-Bike, boarding, or ski helmet- *you will need to provide*
- 2-ply Conductive thread (2-3 yards per project-depending on the design)
- 1-needle (largest eye # 3/9)
- Embroidery hoop to stabilize fabric
- Tracing paper, Taylor's chalk or fabric marking pen
- Embroidery floss in various colors
- Clear nail polish or fray check
- USB A/**micro** B cable (these will be shared with other students)

This project has three major parts;

1. **The garment design,**
2. **programming the Neopixel(s), and**
3. **powering your rechargeable batteries or project with solar panels.**

Part One: Designing Your Garment

Design: Draw an original outline design below or find a design you like on the Internet to give you an idea. Enlarge the design onto large white chart paper making sure it fits the back of a T-shirt or other garment.

Draw your idea here before you start your search. Upload to Google Slides.

Create: Create your wearable electronic project following the grading rubric and the following instructions.

Table 1. Grading Criteria for Grades 6-8.

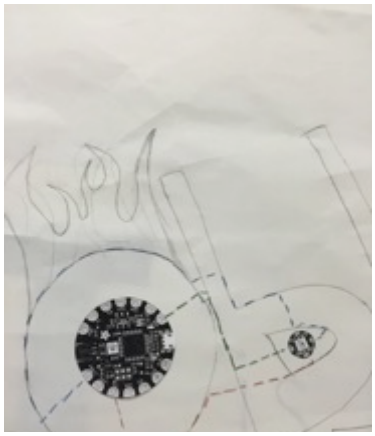
Learning Objectives 6-8 Grade-Student will be able to:	Max Pts	Pts Earned	Grading Criteria		Instructor Initial
Design a wearable circuit garment that people would wear out in public.	10		Outline drawing design traced onto large chart or butcher paper (project pattern)	___/10	
Design a wearable circuit pathway that has at least 1 place for the bright flashing LEDs (NeoPixel) in order to attract attention.	10		Color coded circuit pathway is drawn onto pattern as shown, including photocopied Flora and NeoPixel(s)	___/10	
Sew 3 circuits using conductive thread to the correct tap pads.	60 (20pts./ circuit)		Correctly sewed 3 circuit pathways onto garment from the FLORA to NeoPixel(s).	___/60	
Attach and blend the Flora microcontroller into the garment design.	10		Correct connections were made from the Flora tap pads to the correct NeoPixel.	___/10	
Attach solar panels and battery box to a bike helmet in order to charge batteries.	60		Correctly connected the solar panels to the FLORA or battery box in order to run circuit system.	___/60	
Uniquely program the Flora in order to light up the	30		The FLORA was programmed to have a unique set of colors and	___/30	

NeoPixels to attract attention.			patterns for the garments Neopixel(s).	
Share self evaluation questions about project	25		All questions were completely answered ___/25	
Present project in a final presentation	80		Completed all steps outlined below for final presentation. ___/80	
		Total:	285 pts.	

Project Instructions

Enlarge outline drawing to fit your garment (T-shirt or other fabric) using large white chart paper. This will be the **pattern**.

Figure 1: Pattern on top of T-shirt with Flora placed on top.



Note: Remember to get final approval of your conductive circuitry pathway before you start sewing your garment.

Next:

Think about the circuit pathways that the conductive thread will need be sewn from the **Flora** to the **Neopixel**(s). Make sure the pathway for the **conductive thread** does not touch or cross another stitching line (it's just like wires).

Cut out photocopied paper copy of Flora circuit board and NeoPixel(s). Place them on their design pattern (large paper) and glue onto pattern.

Connecting the Flora to the NeoPixel on the pattern drawing:
Using separate colored pencils, draw your ***circuit stitching path*** around the Flora making sure your future stitching lines do not touch or cross.

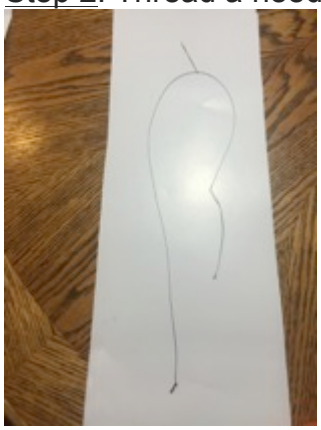
- Draw a **green** stitching line from the **GND** tap pad (next to the D6) on the paper Flora to – **(negative)** tap pad on the paper NeoPixel.
- Draw a **red** stitching line from the **D6** tap pad on the Flora to inward facing arrow 🡐 on the NeoPixel tap pad.
- Draw a **blue** stitching line from the **Vbatt** tap pad on the flora to **+ (plus)** on the NeoPixel.

Get your pattern approved before you move on to sewing with the conductive thread!

Sewing With Conductive Thread:

Step 1: Place your FLORA main board and single pixel on the taut fabric. Use an embroidery hoop to keep fabric tight and a piece of cardboard between the layers of your shirt so you don't sew both side of your shirt together.

Step 2: Thread a needle with 2-ply conductive thread and tie a knot on one end.



Step 3: Pierce the fabric *coming from the back* to front next to the pad marked **GND** on FLORA. Make a few (2-3) stitches through and around the **GND** hole, securing it to the garment.

Step 4: Seal the knot with clear nail polish or fray check. When dry, cut any stray ends close to the knot so you don't cause any short circuits.

Step 5: Following the green path drawn on the pattern, take the needle and conductive thread and poke up through fabric close to the Flora. Now use a running stitch to sew a conductive pathway (stitching line) from the **GND** tap pad (next to the D6) on the Flora to **– (negative)** tap pad on the NeoPixel.

Step 6: Make a few loops through the **– (negative)** tap pad on the NeoPixel in order to secure it to the garment ending at the *back side*. **Using a multimeter, check for connectivity (see instructions below).** Tie a knot and apply some clear nail polish. Let dry. Cut the conductive thread fairly close to the knot when the nail polish has dried.

Step 7: Thread another needle and following the red path drawn on the pattern sew from **D6** tap pad on the Flora to inward facing arrow 🡐 on the NeoPixel tap pad like you did in Step 5.

Step 9: Using a multimeter, check this sewn pathway for connectivity. If you have a good circuit, seal with the clear nail polish or fray check and let dry. Cut the threads close to the knot.

Step 10: Thread your third needle and following the blue path drawn on the pattern, sew a connection the **Vbatt** tap pad on the flora to **+ (plus)** on the NeoPixel.

Step 11: Check this pathway before going on. You will now have *three* independent paths sewn from the main FLORA microprocessor to the NeoPixel.

Step 12: Double check your circuit for stray threads, and get ready to load it with a program that will change the NeoPixels color when you turn on the FLORA.

Part Two: Programming the FLORA microcontroller

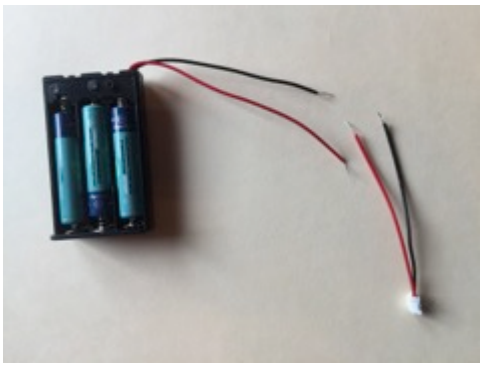
If your teacher has not already downloaded a test program you will need to download test code from Adafruit.com or write a test code.

As long as you have the Arduino program downloaded on a computer, you can access a test code at from the Adafruit website (https://learn.adafruit.com/light-up-angler-fish-embroidery/code) and then you can modify the code to change the colors and pattern sequences.

https://learn.adafruit.com/getting-started-with-flora/overview

Part Three: Converting to Solar

Using the flexible solar panels provided, perform some tests using the worksheet, Portable Solar Battery Charger Challenge, to decide which combination of solar panels will be the *best* to power the FLORA project.



If you are using solar for your project, you will need to cut the wires from the battery pack and the connector in order to connect to the solar panels. See picture to right.

Part 4: Final Testing and Presentation

Final Testing of System:
Now that you have your garment completed, the Flora programmed, and the solar panel hooked up to your system it's time for a final test. Weather permitting, go for a bike ride and test your solar panel! Make sure you are charging your batteries and have glowing NeoPixels.

Reflection Questions/Share (Evaluation Phase):

Before you share your project with the class be sure to answer the following evaluation worksheet questions and be ready to share your findings with the class.

There were three major parts to this wearable project; the conductive circuit, programming the microcontroller, and the solar panel charger.

1. Make a drawing showing the transfer of energy (hint: think of all the components involved - sun, solar panel, rechargeable batteries, conductive thread, FLORA, Neopixel, etc.).

2. **What went well?** Be specific. Don't just say, "the conductive thread stitching". What about the circuit went well? What was special about it? Maybe where you positioned the Flora and NeoPixel, or the materials that were used.

3. Problem solving is a big part of engineering. What didn't go well? Be specific. Explain ***why*** it didn't work as planned. Which part (the sewing of conductive thread, the programming, or the solar panel attachment) was the most challenging for you to solve?

4. What is your favorite **element** (part) of your wearable system? **Why** do you think this?

5. If you had time to redesign again, ***explain*** what changes you would make. "No changes" is not OK to write down, there is always room for improvement. What are your ideas now that you've designed and tested your wearable garment?

6. What suggestions did other students offer for your project? How will you use these suggestions or how would you use them if you could redesign your project?

Final Presentation: After spending time making your awesome wearable electronic garment you have been asked to display it at a well know garment shop in downtown Portland, Oregon. You will need to write an advertisement that explains all the aspects of your design. You may make a poster or give a demonstration using Google Slides.

Be sure to include:

- A picture of your pattern with the stitching lines drawn onto the pattern.
- A picture of your garment as you worked on sewing.
- Schematic diagram of your circuit and description.
- Picture or video of your working circuit.
- Graph (or printed pictures of graphs) of your solar battery recharging tests.
- Results of your solar battery tests.
- Picture or drawing of your battery recharger.
- Reflection questions.