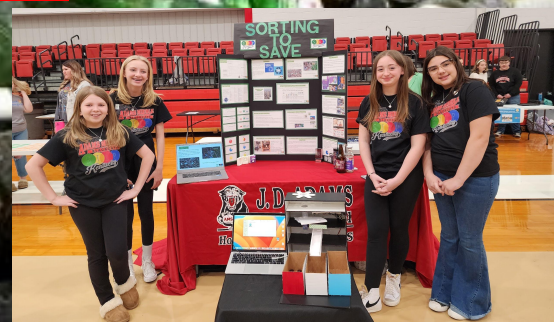


**James D. Adams Middle School
Student Led Project**

Sorting To Save

**Increase Recycling and
Engineer a Glass Sorting Device**

**Advisor: Heather Wheeler
Team: 4 6th graders**



Sorting To Save

Project Summary

In our community, garbage pollution is an issue that we see on the sides of the road, in the creeks, rivers and all over. Many things we throw away can be reused or recycled. Our city recycles plastic bottles, cardboard, and aluminum cans but does not recycle glass. Statistics show that 75% of glass ends up in landfills each year but could be recycled. However, glass needs to be color sorted in order to be more useful when recycled, but many recycling facilities don't have machines to sort the glass. This causes most glass to go to landfills and it takes glass around "4,000 years to decompose and 1-2 million years to fully degrade in a landfill." Kentucky only recycles 22% of glass bottles and jars (Oberk, 2023). On Dec 31, 2023 an Eastern Kentucky company, Ale-8-One, officially ended the bottle deposit and payout program, increasing the amount of glass going to the landfills. This makes finding new ways to recycle glass even more important. We decided that the solution is to increase recycling. To increase glass recycling we created a device that would help sort glass by color to make it easier to recycle. We designed a public receptacle that would be appealing to use and have, wasn't as big and bulky as other solutions, that would automatically sort the glass by color, low cost to produce, and easy for people to use. Our sorter has 80-100% accuracy. We learned about electrical circuits, energy conservation, recycling processes, and that we can make a difference. Glass recycling would save money and energy in our nation, would help the environment, and help clean up our community.

The Issue

When going home from school, taking a walk, or even going to the grocery store this is all we see! This is not just on our street though, we have seen it everywhere and I'm sure you have to. Pollution is a major issue. **Glass Pollution is dangerous.**

Glass has to be color sorted in order to be recycled either by people or by an expensive industrial sorter.

In 3 weeks there is enough **glass** going into **landfills** to fill the Empire State building top to bottom. The **Empire State building** is 1250 ft tall. However, if that glass was being **recycled** it could go from a recycling bin to a store shelf in as little as 30 days.

Kentucky only recycles 22% of glass (Oberk)

Our home town of Prestonsburg can recycle cardboard, aluminum cans (not food cans), newspaper, notebook paper, and printer paper. However, **does not recycle glass**

As of Dec 2023 Ale8-1 had to Stop the Bottle Program. One local company, Ale8-1, used to have a return glass bottles program but the machine that washed and prepared the bottles is beyond repair and they are no longer able to take the bottles back causing even more glass to not be recycled or reused.



THE TYPICAL GLASS BOTTLE
CAN TAKE OVER
4,000 YEARS
TO DECOMPOSE
THIS PROCESS TAKES
EVEN LONGER IF
THEY ARE IN
LANDFILL



Our Solution: Increase Recycling and Make Recycling Glass Possible with a Low Cost Glass Sorter

Start a recycling program at school and assist our community in efforts.

Design and build a prototype of a glass sorting machine that will automatically sort different colors of glass into different bins. We were inspired by a candy sorter that uses light sensors to sort skittles by color.

The glass sorter can help the environment by increasing the amount of glass being recycled. Most recycling facilities will not accept glass that is not sorted unless they have a glass sorting machine.

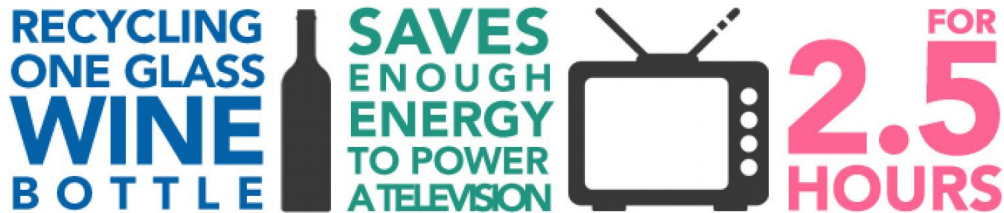
Our goal is for the sorter to be appealing to use and have, is not as big and bulky as other solutions, automatically sort the glass by color, low cost to produce, and easy for people to use.

We want to build a receptacle that could be placed throughout communities. Our receptacle would sort glass by color prior to sending it to a recycling plant. This will help improve glass recycling and make it more efficient.



Benefits of Glass Recycling

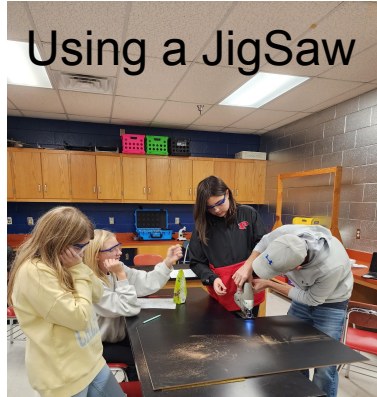
- Glass is one of the easiest materials to recycle
- Glass is infinitely recyclable and won't lose quality
- Reusing the same piece of glass over and over again saves energy because it takes a lot more energy to make a new piece of glass
- Glass produced from recycled glass reduces related air pollution by 20%
- Glass produced from recycled glass reduces related water pollution by 50%.
- Glass recycling reduces CO₂ emissions
- Reduces glass waste going into landfills



Progress in Building the Color Sorter: Tools and Costs

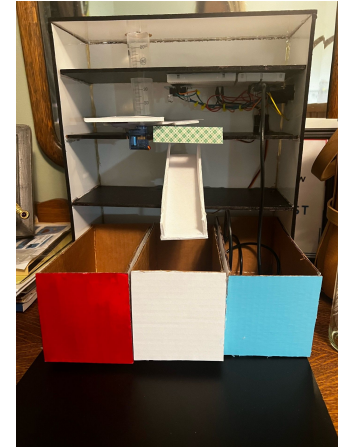
The Tools Used:

- Chromebooks,
- Google sites, slides, forms,
- TCS230 TCS3200 Color Sensor,
- Arduino Nano,
- Arduino online code editor
- Breadboard,
- Jumper Wires,
- Servo Motor,
- 3D Printer/Tinkercad,
- Switch
- Power jack
- Jig saw
- Box cutters
- Hot glue gun
- Voltmeter
- Ruler
- Measuring tape



TCS230 TCS3200 Color Sensor.....	\$19.99
Arduino Nano	\$26
Breadboard and Jump Wires	\$9.99
Servo Motor	\$7.99
Switch.....	\$6.97
Power Jack.....	\$6.99
Board.....	\$10
Total \$87.93	

The prototype is less than \$100. An actual bin could be made for around \$200.

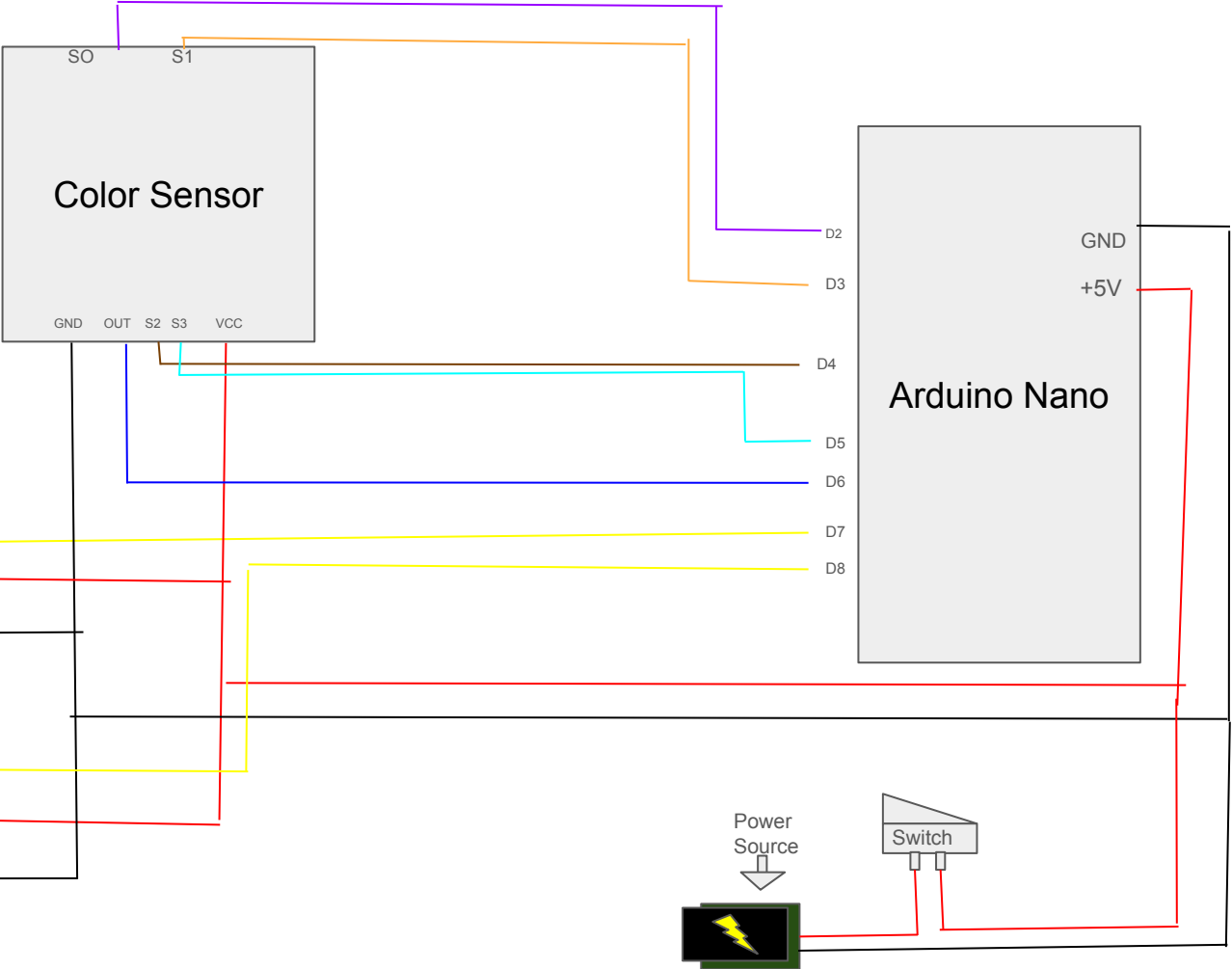


Electrical Circuit We Wired Inside the Sorter



Servo Motor
(Moves glass to
and from sensor)

Servo Motor
(Moves chute)



The Circuit

The Line Code

In order to program our sensor we had to run calibration tests for each glass color to determine their (R, G, B) filter frequencies



```
/* Arduino Project - Color Sorting Machine
 *
 * by Dejan Nedelkovski, www.HowToMechatronics.cc
 */
#include <Servo.h>
```

```
#define S0 2
#define S1 3
#define S2 4
#define S3 5
#define sensorOut 6
```

```
Servo topServo;
Servo bottomServo;
```

```
int frequency = 0;
int color=0;
```

```
void setup() {
  pinMode(S0, OUTPUT);
  pinMode(S1, OUTPUT);
  pinMode(S2, OUTPUT);
  pinMode(S3, OUTPUT);
  pinMode(sensorOut, INPUT);
```

```
  // Setting frequency-scaling to 20%
  digitalWrite(S0, HIGH);
  digitalWrite(S1, LOW);
```

```
  topServo.attach(7);
  bottomServo.attach(8);
```

```
  Serial.begin(9600);
}
```

```
void loop() {
  topServo.write(115);
  delay(500);
```

```
  for(int i = 115; i > 65; i--) {
    topServo.write(i);
    delay(2);
```

```
  }
```

```
  }
  delay(500);

  color = readColor();
  delay(10);

  switch (color) {
    case 1:
      bottomServo.write(50);
      break;

    case 2:
      bottomServo.write(75);
      break;

    case 3:
      bottomServo.write(100);
      break;
```

```
    case 4:
      bottomServo.write(125);
      break;

    case 5:
      bottomServo.write(150);
      break;

    case 6:
      bottomServo.write(175);
      break;
```

```
    case 0:
      break;
  }
  delay(300);

  for(int i = 65; i > 29; i--) {
    topServo.write(i);
    delay(2);
  }
  delay(200);
```

```
  for(int i = 29; i < 115; i++) {
    topServo.write(i);
    delay(2);
```

```
  }
  color=0;
}
```

```
// Custom Function - readColor()
```

```
int readColor() {
  // Setting red filtered photodiodes to be read
  digitalWrite(S2, LOW);
  digitalWrite(S3, LOW);
  // Reading the output frequency
  frequency = pulseIn(sensorOut, LOW);
  int R = frequency;
  // Printing the value on the serial monitor
  Serial.print("R= "); //printing name
  Serial.print(frequency); //printing RED color frequency
  Serial.print(" ");
  delay(50);
```

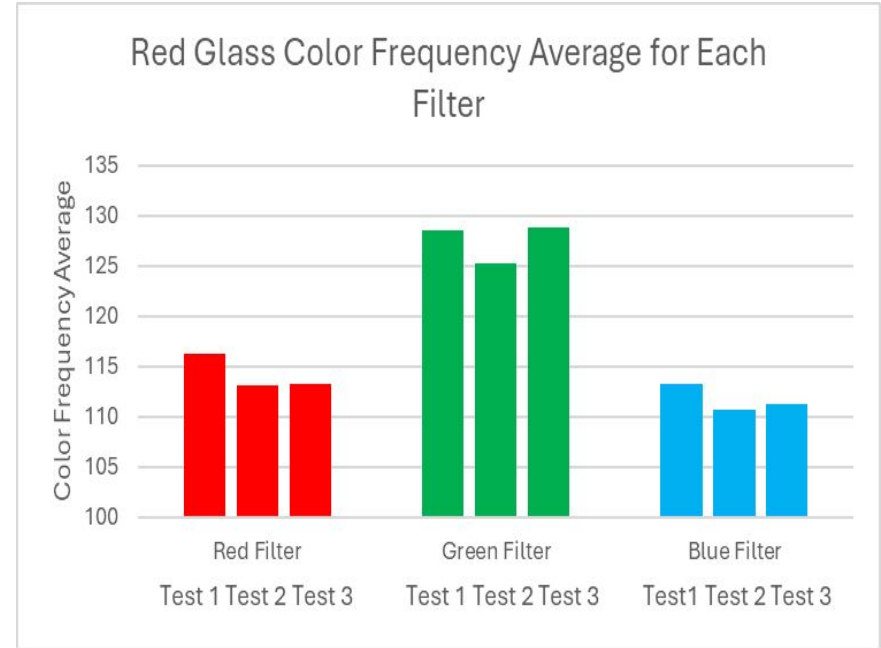
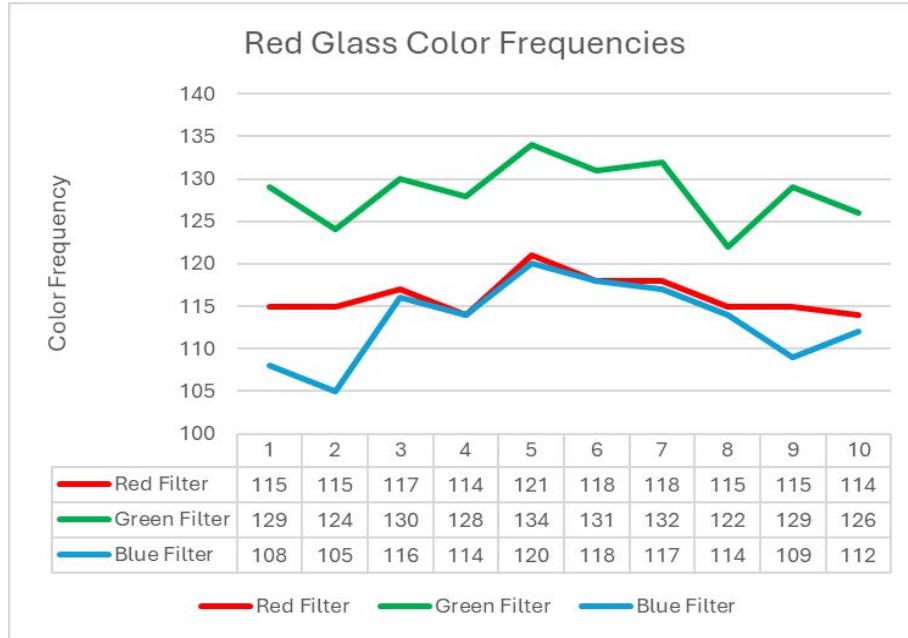
```
  // Setting Green filtered photodiodes to be read
  digitalWrite(S2, HIGH);
  digitalWrite(S3, HIGH);
  // Reading the output frequency
  frequency = pulseIn(sensorOut, LOW);
  int G = frequency;
  // Printing the value on the serial monitor
  Serial.print("G= "); //printing name
  Serial.print(frequency); //printing RED color frequency
  Serial.print(" ");
  delay(50);
```

```
  // Setting Blue filtered photodiodes to be read
  digitalWrite(S2, LOW);
  digitalWrite(S3, HIGH);
  // Reading the output frequency
  frequency = pulseIn(sensorOut, LOW);
  int B = frequency;
  // Printing the value on the serial monitor
  Serial.print("B= "); //printing name
  Serial.print(frequency); //printing RED color frequency
  Serial.println(" ");
  delay(50);
```

```
  if(R<45 & R>32 & G<65 & G>55){
    color = 1; // Red
```

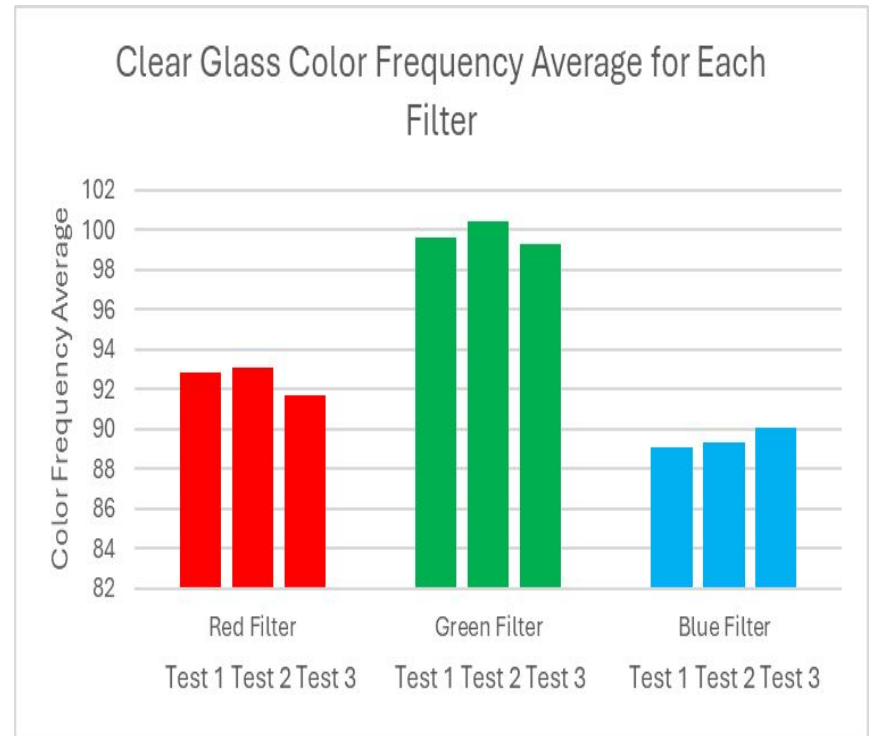
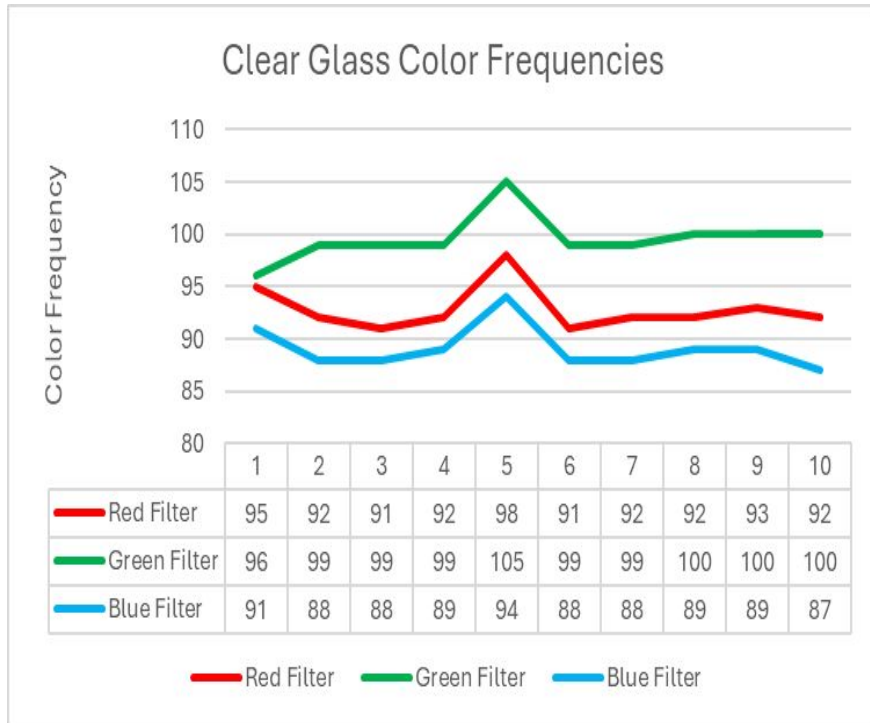
```
  }
  if(G<55 & G>43 & B<47 & B>35){
    color = 2; // Orange
  }
  if(R<53 & R>40 & G<53 & G>40){
    color = 3; // Green
  }
  if(R<38 & R>24 & G<44 & G>30){
    color = 4; // Yellow
  }
  if(R<56 & R>46 & G<65 & G>55){
    color = 5; // Brown
  }
  if (G<58 & G>45 & B<40 & B>26){
    color = 6; // Blue
  }
  return color;
}
```


Red Glass Color Frequencies



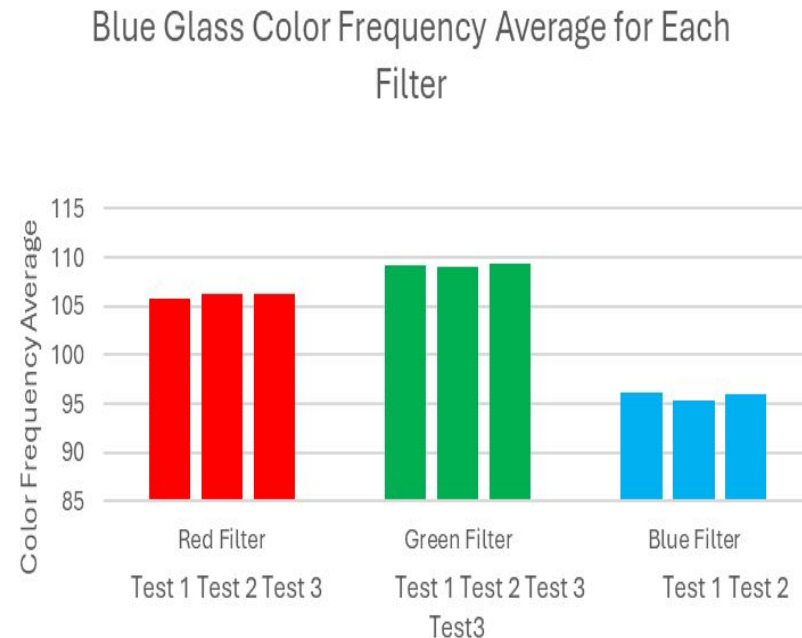
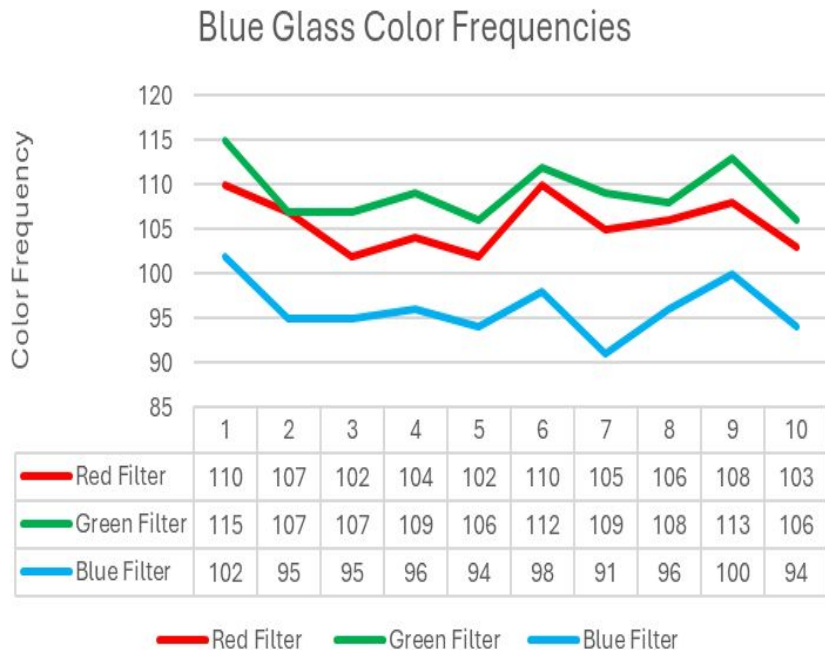
($R < 122$ & $R > 105$, $G < 135$ & $G > 115$)

Clear Glass Color Frequencies



($R < 105$ & $R > 90$, $G < 108$ & $G > 96$, $B < 97$ & $B > 85$)

Blue Glass Color Frequencies

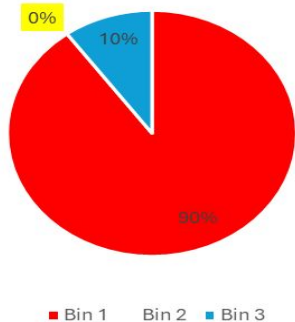


($R < 112$ & $R > 98$, $G < 120$ & $G > 100$, $B < 105$ & $B > 87$)

Our Machines Accuracy:

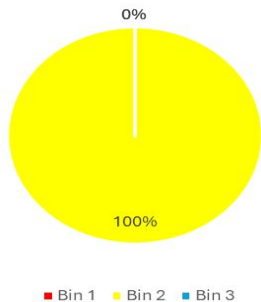
Different Lighting Conditions

Red Glass Accuracy

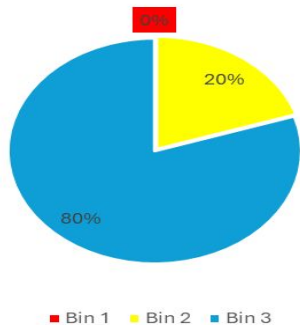


Lights On

Clear Glass Accuracy

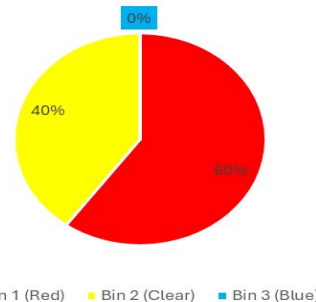


Blue Glass Accuracy



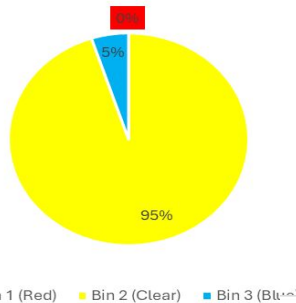
The sorter must be calibrated to the lighting conditions. We calibrated it to “lights on” to be able to show how it works but could have higher accuracy with lights off when bin is closed if we re-calibrate the sensor.

Red Glass Accuracy With No Outside Light Source

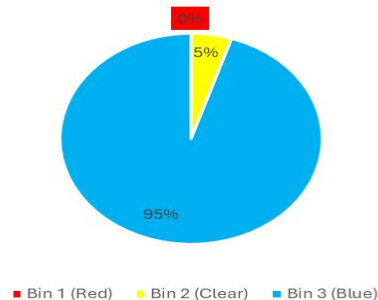


Lights Off

Clear Glass Accuracy With No Outside Light Source

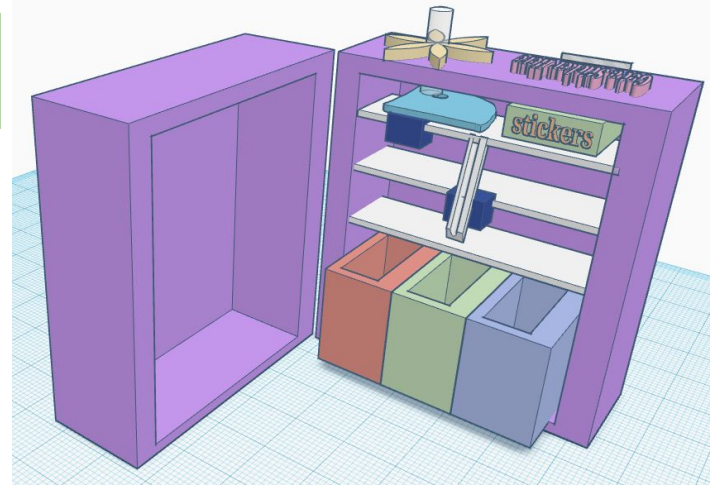


Blue Glass Accuracy With No Outside Light Source



Our Future Modifications

- Make an actual sized enclosed receptacle to help eliminate outside light using 3D printed parts.
- Upscale our model a lot more and make it a durable weather resistant receptacle
- Calibrate our machine to sort for the three most common colors of glass (Clear, Amber, and Green)
- Weather resistance: Add features to our dispenser so that rain does not get inside
- Add motion sensor to the machine so the program is not constantly running and more is energy efficient
- Code the machine to dispense stickers or payment as a reward for when people recycle their glass



3D Model designed on Tinkercad





Visit our Website to Learn More

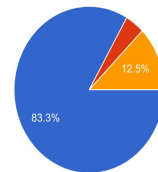
Project Impact

- Created and tested a prototype of our glass sorter showing the device is possible at a low cost
- We presented to city officials and joined city recycling efforts.
- We got to tour the recycling plant to get more info from our city about local recycling processes.
- Started an official recycling program in our school and received large blue recycling cans as well as an outdoor recycling sorter. We collect cardboard, paper, plastic, and glass bottles/jars.
- Our city has committed to work with Ale8-1 to start recycling glass. Working with Ale-8-1 to help our city join the Commonwealth Collective Program to include glass in our recycling efforts.
- We have collaborated with Rumpke to learn more about the recycling process at their facility.
- Rumpke sorts, washes, and recycles glass and sends it to other places to be turned into bottles or insulation.
- Currently Rumpke does not service our county but might in the future.
- Inquired about partnering with Rumpke to start glass recycling in our county. Invited to SOAR meeting to present and network.
- 30 people have heard our presentation so far
- 24 people have pledged to recycle in some way and more will as they hear our presentation



I pledge to help save the environment by reusing and recycling glass and other materials as much as possible.

24 responses



● I pledge to do all I can.
● I pledge to reuse glass jars and bottles
● I pledge to recycle

Resources

Ale-8-1. 2023. KEEP THE MEMORIES AND THE BOTTLE AS TREASURES: THE RETURNABLE BOTTLE PROGRAM IS COMING TO AN END. <https://ale8one.com/longnecks/>
Arduino. 2023. Code. Nov. 2023 <https://create.arduino.cc/editor/hdwheeler/ec46e2cf-b3a9-4ffe-9167-6d2ba8a1a0e0>

Dejan Nedelkovski, How to Mechanics. <https://howtomechanics.com/projects/arduino-color-sorter-project/>
Lexington Herald Leader. Oct 10, 2023. Ale-8-One announces the end of an era with a big change to its green bottle. Oct. 20, 2023. <https://www.kentucky.com/lexgoeat/food/article280347739.html>

Great Forest. MARCH 20, 2019. The Glass Recycling Problem: What's Behind It, and What to do. Oct 30, 2023.
<https://greatforest.com/sustainability101/the-glass-recycling-problem-whats-behind-it-and-what-to-do/#:~:text=Most%20manufacturers%20require%20recyclable%20glass,become%20too%20difficult%20to%20reprocess>

Google Shopping search for recycling receptacles. Jan 2023.
https://us.shopping.search.yahoo.com/search:_ylt=AwrihEJ158Jl.oIDhyFgmolQ;_ylc=X1MDMTM1MTE5NTIzMgRfcgMyBGZyA21jYWZlZQRmcjIDc2ltdG9wBGdwcmlkA2JWVaDRsQ1c0VGtlOW0uOGZvcnJXQ0EEbl9yc2x0AzAEbl9zdWdnAzAEb3JpZ2luA3VzLnNob3BwaW5nLnNlYXJjaC55YWVhby5jb20EcG9zAzAEcHFzdHIDBHBxc3RybAMwBHFzdHJsAzUyBHF1ZXJ5A2NvbG9yZWQIMjBnbGFzcUyMHNvcnRpbmclMjBwdWJsaWMIMjByZW50cHRhY2x0JTlwaW50cHRhY2x0c2UUEdF9zdG1wAzE3MDcyNzlwOTY-?p=colored+glass+sorting+public+receptacle+bin+purchase&fr2=sb-top&fr=mcafee&vm=r&type=E211US105G0

Marabito, Maria. April 6, 2023. Treehugger. How to Recycle Glass Correctly. Oct. 30, 2023.
<https://www.treehugger.com/how-to-recycle-glass-correctly-5185806#:~:text=Either%20way%2C%20when%20recyclables%20arrive,where%20it%20is%20sorted%20again.>

Oberk. 2023. Which States Are the Best (or the Worst) at Recycling? Nov. 2023. <https://www.oberk.com/packaging-crash-course/states-best-worst-recycling>

City of Prestonsburg. Public Works Department. 2023.
<https://prestonsburgcity.org/public-works-department/#:~:text=To%20All%20Prestonsburg%20Recycling%20Customers%3A&text=The%20items%20that%20we%20have,as%20notebook%20and%20typing%20papers>

Remolador, Mary Ann. January 17, 2023. Overcoming obstacles. Oct. 2023.
<https://resource-recycling.com/recycling/2022/12/14/overcoming-obstacles/>

Rumpke. 2024. Glass Recycling and Videos. Nov. 6, 2023. <https://www.rumpke.com/for-your-home/recycling/glass-recycling> ; <https://www.rumpke.com/about-us/education/recycling-videos> ;
<https://youtu.be/D5VrLAF-afA>

World Wide Fund For Nature. 2020. Recycling Glass: How it Helps the Environment. Oct 28, 2023 https://wwf.panda.org/discover/knowledge_hub/teacher_resources/project_ideas/recycling_glas
WKYT Investigates: Lack of garbage pick-up blamed for Lake Cumberland trash. Dec 2023.
<https://www.wkyt.com/content/news/WKYT-Investigates-No-mandatory-county-garbage-pick-up-blamed-for-Lake-Cumberland-trash--427288253.html>