

# **Team C01 - 1**

**Deliverable H - Prototype III and Customer Feedback  
Engineering Design - GNG1103**

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March 26, 2023

## ***Abstract***

*In the previous deliverable, we presented our second prototype along with a test plan, images, future goals, client feedback, and more. In this deliverable, we will present similar information based on our third and final prototype. We wish to deliver a concluding and fruitful summary on our progress for developing this product, which we believe is closest we've reached to our client's needs and design criteria.*

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# 1. Introduction

In our previous deliverable we were tasked with developing our second deliverable, gathering feedback from our clients, and updating our bill of materials adequately. The purpose of this deliverable is to present similar content to our previous deliverables based on our final prototype. This deliverable is divided into two parts: Feedback and Prototype III.

## 2. Feedback

### 2.1 Client Feedback

While we did not gain any actionable feedback since our pitch presentation on March 10, 2023, we looked back upon our design criteria, needs, and feedback from previous prototypes. We decided to expand upon the concept of switch sensors that could detect multiple cans, no matter their orientation. Our purpose was to create a wider laser cut box, made of MDF and hot glued together like our second prototype. We decided to make the arms of the sensors long enough to reach all cans from the side of the line, as our client insisted we shouldn't mount the sensors on top so that the arm wouldn't touch the lid. We strived to create a 4-can wide line, rather than a single file line because of earlier feedback from our client which stated that their line can be up to 24 cans wide.

We feel that all major feedback from our client was taken into consideration, and that we have prepared a final prototype that can reflect the client's needs. We hope that these changes to our product can garner their approval.

## 3. Prototype III

By the end of our second prototype we devised a plan to further improve our emulation of the production line and build upon testing results and lessons we learned while working with previous prototypes. Prototype III reflects these changes and improvements.

### 3.1 Conveyor Emulation

The purpose of this prototype is to implement a:

- Scalable width of conveyor for both can and bottle lines
- Refined code for sensors detecting multiple cans at a time
- Output in CPM and %efficiency
- Output in BPM and %efficiency

The purpose of this prototype is to implement three different conveyor widths to show the adaptability of the production line, for can and bottle lines, as well as adapted the code to work for several switches than ever before and display outputs (CPM, BPM, %efficiency). We must ensure that our sensors can easily adapt from can lines to bottle lines.

### 3.2 The Can Line

The most notable improvement to our can line is its increase in capacity. The new can line is capable of storing multiple cans at once (4 cans wide), and placed in any formation. It's made out of the same material (MDF) as our second prototype as we found it to be durable and easier to work with, so we decided to stick with it. All the pieces were laser cut and hot glued together in the MakerSpace. We also decided to re-use our arduino case from prototype II.

*Figure 1: Prototype III Production Line Emulator*



Figure 1 shows our latest can line. Designed to contain multiple cans (up to 4 wide) rather than a single file from our previous prototype.

*Figure 2: Prototype III Overall Can Line Setup*

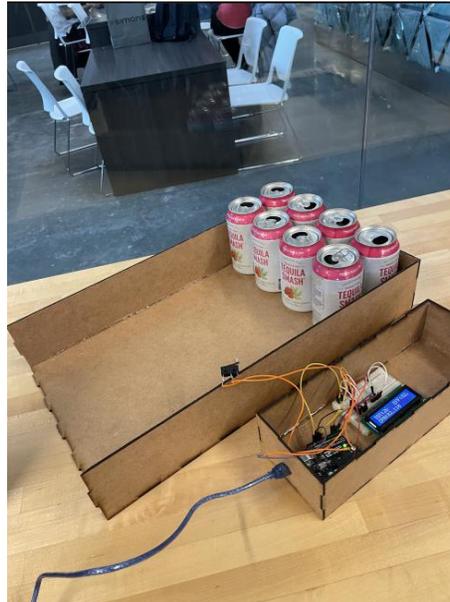


Figure 2 represents how cans, along with sensors and circuitry would be set up. Multiple sensors could be placed around the box and the code can allow for one activation to count for as many cans as desired.

In figure 2, we decided to place one switch, and due to the cans' formation, we allowed for one switch activation to account for 4 cans passing through (as they are placed in rows of 4 cans wide). The arduino case has a cover to maintain the setup aesthetically pleasing, but for the purpose of demonstration we decided to leave the circuitry open.

### **3.3 The Bottle Line**

In this prototype, we also decided to expand our testing and emulation to include bottles in the process. We decided to make use of our old box production line (from prototype II) to test and tailor our sensors and code for bottles. This helped us improve our sensor's adaptability from cans to bottles. We made sure to take into account the dimensions of the bottles as well as their weight in order to allow for the sensors to detect them efficiently. This process was done relatively quickly and we didn't have to manipulate our code at all. Figure 3 shows the bottle line setup.

*Figure 3: Prototype III Bottle Line Emulator*



The bottle line box represented in figure 3 has found a new use in the development of our final product by helping us ensure the adaptability of the sensors.

### **3.4 Code and Circuitry**

The code for this prototype was vastly improved. While we were limited to only single file lines of cans in our previous prototype, this code was adapted to detect up to 4-cans wide, which can be grouped in any formation and still be detected accurately. We also adapted our code to display a counter, CPM/BPM, and %efficiency all in one using an LCD display, as we were limited to displaying one value (%efficiency) on the 7 segment display from prototype II. We added another breadboard to be able to fit the LCD display. Figure 4 shows the updated display and circuitry.

Figure 4: Prototype III LCD Display and Circuitry

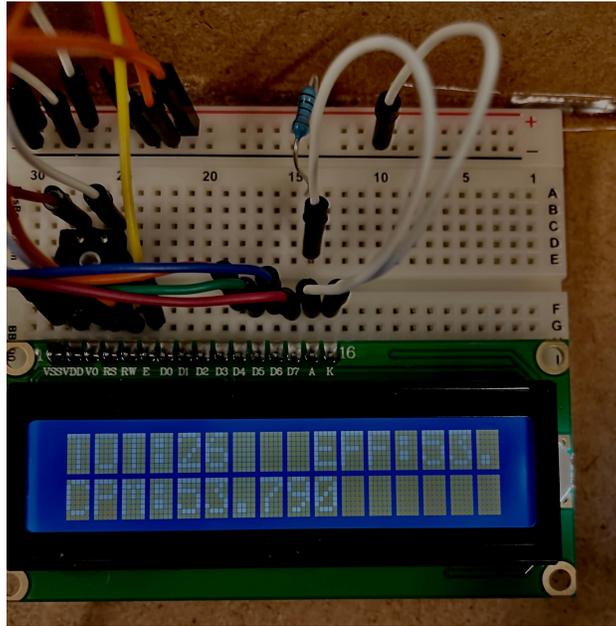


Figure 4 captures the LCD display. ‘TOT’ represents the total cans detected, ‘EFF’ represents the %efficiency, ‘CPM’ represents cans per minute.

The following code was used for our final prototype on the arduino IDE:

[https://create.arduino.cc/editor/diego\\_robles123/30069c5b-2276-42cb-8ef6-0460cbf1ea00/preview](https://create.arduino.cc/editor/diego_robles123/30069c5b-2276-42cb-8ef6-0460cbf1ea00/preview)

### 3.5 Prototyping Testing Plan

After our third prototype is completed it will be tested by running a multitude of random arrangements of cans through the sensors. Since cans can come through the conveyor in any arrangement and formation, we need to run extensive tests with random formations and arrangements in order to simulate as many possible scenarios as possible to ensure that our sensors produce accurate data in all possible scenarios.

The two “variables” affecting the accuracy of our data are the code for our arduino and the physical sensors. To test the accuracy of the physical sensors, cans will be run through a “conveyor”. As each sensor is triggered, a light on our arduino will flash. If the sensors are defective, the light will not flash and the necessary fixes will have to be made. To test the code, our output of cans passing through the line given to us by the arduino must match the arbitrary amount of cans we put into the conveyor. If these do not match, either the code is defective or the sensors and fixes will have to be made and more testing carried out. This model will allow for 4 cans to pass through instead of a single file line. We will also perform similar tests on a bottle line “conveyor”.

*Table 1: Prototype III Test Plan*

<b>Test ID</b>	<b>Test objective</b>	<b>Description of Prototype used and of Basic Test Method</b>	<b>Description of Results to be Recorded and how these results will be used</b>	<b>Estimated Test duration and planned start date</b>
<b>1</b>	<b>Efficiency of sensor</b>	<p><b>Prototype III.</b></p> <p><b>Finding the best placement for our sensors along our production line box for the can line and bottle line.</b></p> <p><b>Ensuring the sensors are gathering the correct information.</b></p>	<p><b>By marking where the sensor should be placed on the physical boxes.</b></p> <p><b>Looking at the arduino IDE.</b></p> <p><b>Looking at the arduino display.</b></p>	<b>March 25 2023, 30 mins</b>
<b>2</b>	<b>Verifying feasibility</b>	<p><b>Prototype III.</b></p> <p><b>We will make sure to keep the circuitry and hardware easy to use and even interpret by anyone. Applies to both can and bottle lines.</b></p>	<b>Minimizing the amount of unnecessary space and containing any unaesthetic parts in a case.</b>	<b>March 25 2023, 30 mins</b>
<b>3</b>	<b>Sensor accuracy (Can Line)</b>	<p><b>Prototype III.</b></p> <p><b>Pass cans through the sensors to activate them. Pass a total of 66 cans through sensors. Cans must pass in rows of 2, 3 then 4 at a time</b></p>	<b>When the sensors correctly detect and count at least 95% of the cans passing under it, the test will be successful. Repeat steps for rows of 2, 3 and 4.</b>	<b>March 25 2023, 40 mins</b>

4	<b>Sensor accuracy (Bottle Line)</b>	<b>Prototype III.</b> <b>Pass bottles through the sensors to activate them. Pass 50 bottles through sensors.</b>	<b>When the sensors correctly detect and count at least 95% of bottles, the test will be successful</b>	<b>March 25, 2023, 30 mins</b>
5	<b>Durability test</b>	<b>Prototype I, II, and III.</b> <b>To compare the durability of our first 2 prototype production lines to our latest one. Check durability of all cases containing hardware as well as production line boxes.</b>	<b>Finding weak points.</b>	<b>March 25 2023, 10 mins</b>

Table 1 represents 5 tests to be conducted for improving and finalizing the technical functionality of our final prototype.

Regarding the tests detailed above, we were able to complete them all successfully, and found optimal placements for sensors. The code was adapted appropriately to display the correct information, although initially it took some testing and editing to correct it. We didn't find many problems with the physical and action components of our prototype. Finally, we were able to achieve 100% sensor accuracy.

Test resources: Maker Space Area (STM). Laser cutter, basic tools, recycled cans and bottles, prototype II materials, scraps.

Wrike Link (feel free to email me at drobl020@uottawa.ca for access, if necessary):  
<https://www.wrike.com/workspace.htm?acc=5929337&wr=20#/folder/1080997169/tableview?viewId=149000067>

## 4. Conclusion

In regards to prototype III, we are quite satisfied with our final representation of our production line efficiency system. We were able to expand the scale of our can line and adapt our sensors to it in an efficient manner. We were also able to adapt our sensors to our bottle line, which also underwent successful testing. Although we did not have the chance to gather feedback from our client, we were able to improve our product based on earlier feedback.