
Pre-Eng10
2020
FILLETeers'
Design
Booklet.

Table of Contents.

The FILLETeers

The name originates from the filleting action in solidworks represents various aspects that a team requires to be successful; the necessity of having a **smooth flow** where they can take the ''edginess" away, considering **safety** as the most important, and having a curvature for **other teams to fall right off**.

What to Do?

A can crusher needs to be built which can eliminate a can to ½ its size, while completely automating all processes, including the ejection of the can and the loading of 4 or more stored cans. For safety reasons, it is necessary to have a kill switch so the human supervisor can take immediate action. All of this needs to be placed on a station with strength to withhold all weights and forces, while using 3d printed parts for environmental benefits.


Recycling Research
Schwabenstolz
Applet

Operation & Application

What is waste reduction?

Waste reduction/prevention is the preferred approach to waste management as unexisting waste does not have waste management costs.

Waste reduction helps reduce the generation of Harmful and persistent wastes in the environment, by reducing the amount of unnecessary packaging on any goods or produce.

In a way, waste reduction helps support efforts to promote a more sustainable society.

What is recycling?

Recycling is the process of processing used materials into new/useful products without using more raw materials to make the same product that could be made out of recycled materials for much cheaper.

What kinds of materials are recycled in the manufacturing industry?

In the manufacturing industry almost anything that can be recycled will be recycled. An example of the kind of materials that would be recycled would be any excess material created during a manufacturing process which uses a die cutting machine. This excess material is then recycled to be used as material for the same product it came from. The types of materials that are commonly used in these processes and other process are: glass, paper, and cardboard, metal, plastic, tires, and textiles.

Waste Reduction Machines

Shredders:

An trash shredder is a machine used for reducing the size of all kinds of waste material, by the process of breaking the material down.

Some examples of the waste materials that are commonly broken down are: tires, metals, cars (cars can be considered a waste material), woods, and plastics. There are no common uses of a waste shredder as they can shred any type of material depending on the size and design of the shredder. a waste shredder is usually used to reduce the size and weight of a material for easier separation and to lower the recycling and transport of the material but a common use is the reuse of the material by shredding metals, plastics, and cars and as well as other waste materials such as municipal waste or sometimes nuclear waste, hazardous waste, and common garbage.

Compactors:

A trash compactor is a machine or mechanism used to reduce the size of wastes through compaction, most of the time the pressure for compaction comes from the use of a hydraulic cylinder. these compactors are often used by homes or business to reduce the volume of trash they produce.

Multiple retail and service industries such as fast food, hotels , and restaurants, use trash compactors to reduce the amount of non-recyclable waste, and recyclable waste. These compactors typically electric and hydraulic operated, with quite a few loading configurations. some of the most popular loading configurations fall under the following: Ground-access, Walk-on, and Secured indoor chute. These compactors almost always use a welded steel construction for two reasons: durability to pressure and exposure to the elements, as compactors are usually installed either completely outdoors or under a covered loading dock.

Machine & Application History

Assorted Recycling Bins - *Application*

The first occurrence of organised solid waste management system appeared in London in the late 18th century, though it was mainly built for economic purposes, so companies can save money during the industrial revolution.

The Metropolitan Board of Works was the first citywide authority that centralized sanitation regulation for the rapidly expanding city, London, and the Public Health Act 1875 made it compulsory for every household to deposit their weekly waste in 'moveable receptacles' for disposal - the first concept for a dustbin.

When recycling was introduced, the public had to use different bins for discarding their garbage, starting from the late 1900s.

Pneumatics - *Machine*

As with many forms of technology, the first use of a form of pneumatic technology dates back many thousands of years. In this instance, a Greek mathematician by the name of Hero of Alexandria wrote in the first century about how he used wind to generate power and transport.

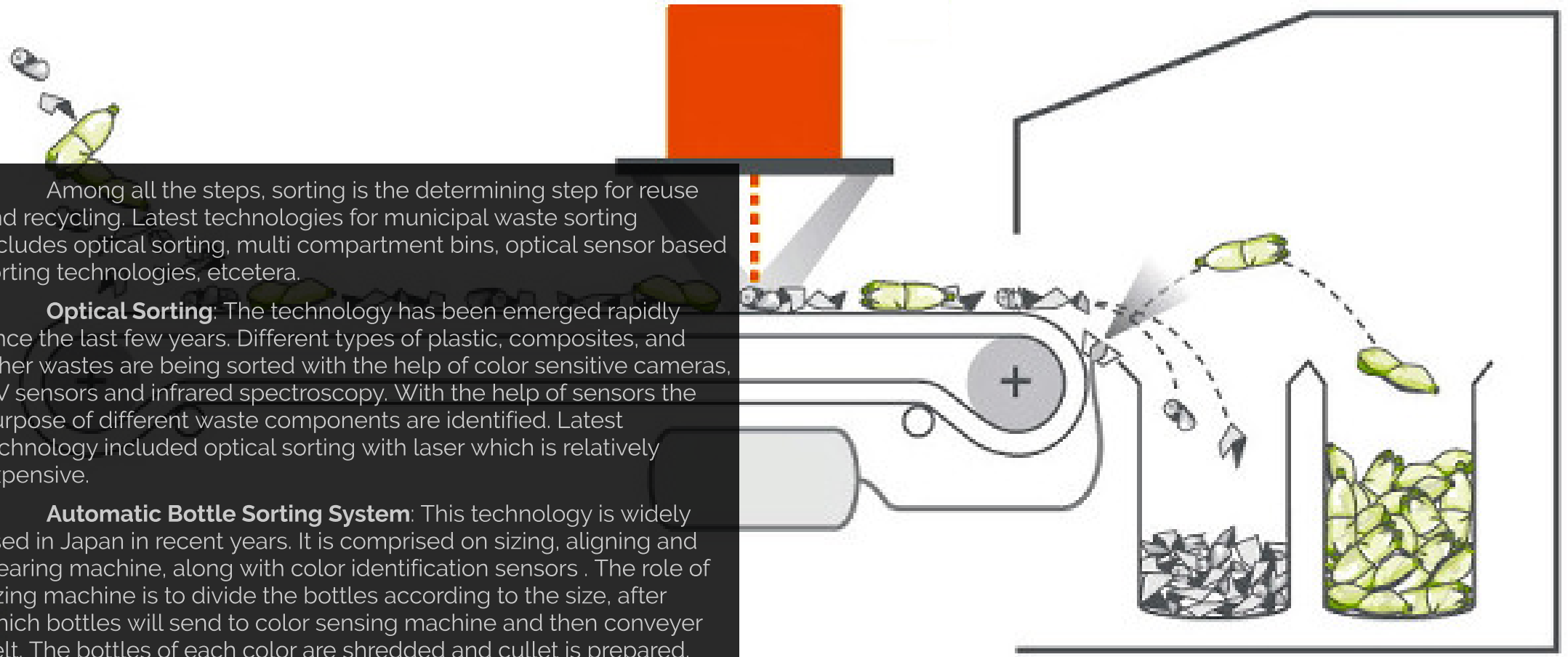
In the 1600s, German physicist Otto von Guericke first invented a vacuum pump that utilized air pressure.John Wanamaker in the 1800s, an American merchant was the first to introduce pneumatic tubes in the United States Post Office to quickly transport letters from one area of the building to another.

In the mid-late 1900s, when recycling went big, the idea of using pneumatics to crush cans became popular alongside crushing other objects.

Collection & Transport

Modern collection and transportation of municipal solid waste involve many technical steps and emerging technologies in integrated waste management system . The overlapping of information technology with waste management syswtem give raise to many innovative technologies in the way of sustainable development. Latest technologies including underground collection system, Web based GIS(geographic information system) technology, Waste bin monitoring system using IoT(Internet of Things), and Waste compactors are being discussed further.

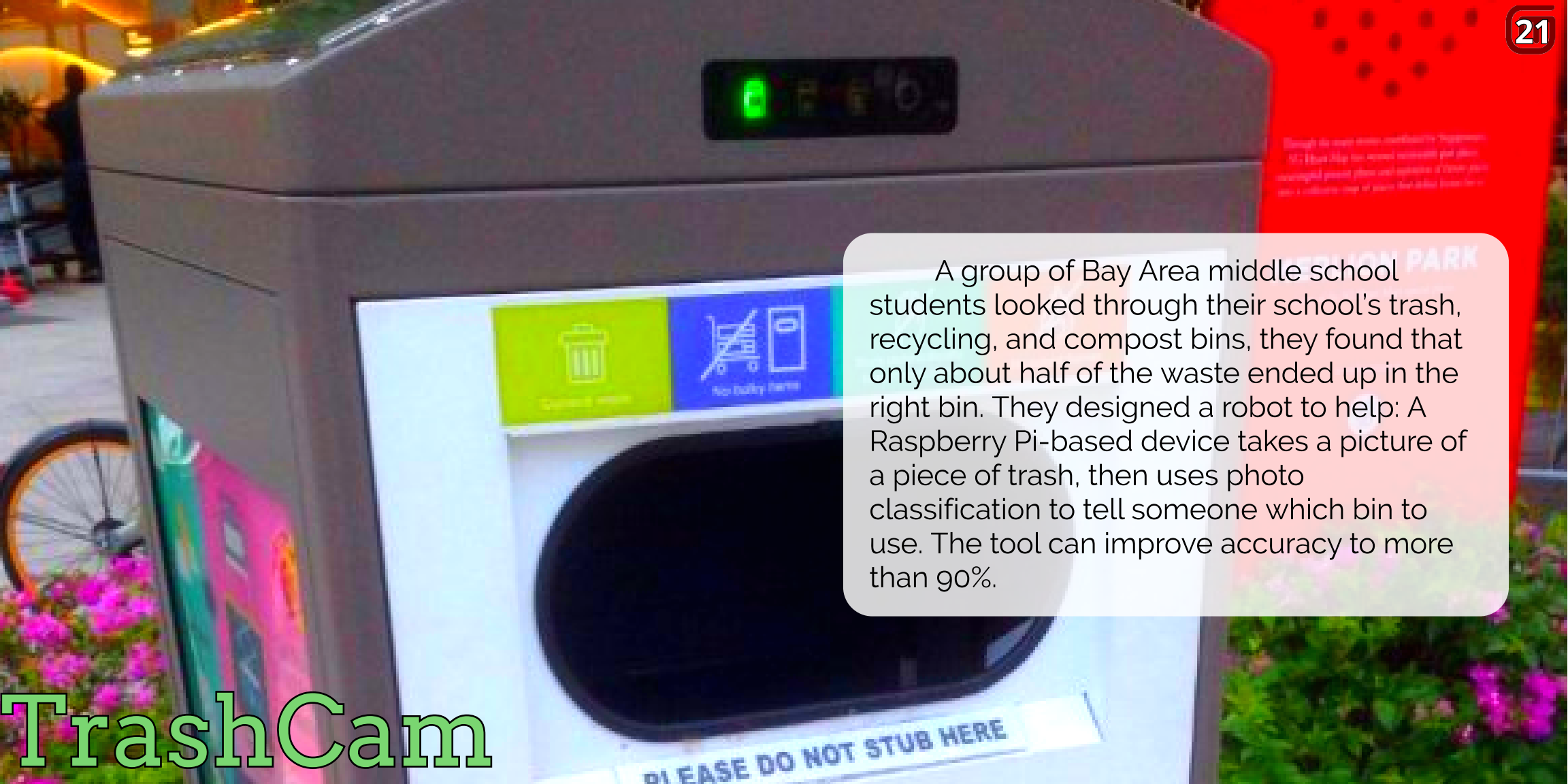
Segregation & Sorting



Among all the steps, sorting is the determining step for reuse and recycling. Latest technologies for municipal waste sorting includes optical sorting, multi compartment bins, optical sensor based sorting technologies, etcetera.

Optical Sorting: The technology has been emerged rapidly since the last few years. Different types of plastic, composites, and other wastes are being sorted with the help of color sensitive cameras, UV sensors and infrared spectroscopy. With the help of sensors the purpose of different waste components are identified. Latest technology included optical sorting with laser which is relatively expensive.

Automatic Bottle Sorting System: This technology is widely used in Japan in recent years. It is comprised on sizing, aligning and clearing machine, along with color identification sensors . The role of sizing machine is to divide the bottles according to the size, after which bottles will send to color sensing machine and then conveyer belt. The bottles of each color are shredded and cullet is prepared. Through this volume of waste is reduced and cullet can be further used in different fields.



TrashCam

A group of Bay Area middle school students looked through their school's trash, recycling, and compost bins, they found that only about half of the waste ended up in the right bin. They designed a robot to help: A Raspberry Pi-based device takes a picture of a piece of trash, then uses photo classification to tell someone which bin to use. The tool can improve accuracy to more than 90%.

Waste Reduction Article Summary

Having too many raw materials can cause a company to discard tons of materials, if companies don't take the material amount calculations into account.

The inefficiency in the manufacturing machinery, can cause incidents where a product is waiting on the conveyor belt too long, and cause the product's shelf life to be reduced dramatically. The same issue occurs when looking at overproduction, where the production line is faster than retail sales.

In certain instances, products can fall off a moving belt, which seems small, but overtime, it leads towards major product loss.

If machines aren't structurally stable, they can cause the product on them to be discarded it because it was exposed to irreparable damage.

Unnecessary transports do not only burn fuel, but they cause product to be damaged, and possibly misplaced.

If you go above and beyond what is required by the customer, and your product will be disposed no matter how strong it is, it translates to all the extra material you used to garbage .

Impacts of Recycling

Societal Impacts

Recycling helps protect the environment. Recycling reduces the need for extracting (mining, quarrying and logging,) refining and processing raw materials all of which create substantial air and water pollution. Because recycling saves energy, it also reduces greenhouse gas emissions.

Economical Impacts

Recycling saves money mainly on the manufacturing part of the economy. Reducing the amount of raw materials extracted from operations such as, logging/foresting, Quarrying and mining

End Goal

The ultimate goal of waste reduction and recycling, is to reduce the amount of pollution produced by waste and to achieve all our environmental goals to be at balance.


Precious
Plastic

Who: Individual/Organization has made a significant contribution to the recycling field?

- Precious Plastic
- Precious Plastic is a Global Community that works together with hundreds of people to find a solution to plastic pollution.

Impact: What other events occurred as a result?

- An impact Precious Plastic has contributed to around the world is making affordable machines that are made from basic materials and easy to put together.

Money: did the individual or organization profit form the ideas?

- Precious plastic is ran by donations from people worldwide who contribute to Precious Plastics cause, it is also run by the merchandise Precious Plastic sells on their website.
- Although precious plastic is not a big company, the ideas on the website enables people to download the blueprints of the ideas and make them themselves. Their income is all donations and they receive about $2000 a month in donated cash, but it is going up quickly.

What: Biographical information.

- Precious plastics biography is spread across the world.

When: Year idea, product or process first used.

- Precious Plastic was started by Dave Hakkens in 2013

Where: Location

- The website does not give us a specific location to a head office, but we have found that this website is an open source website for blueprints and other ideas to make plastic recycling machines and recycled merchandise.

Why: Reasons for developing the idea, product or process

- A reason for developing the idea of Precious Plastic is to reuse and reduce plastic waste throughout the world by giving people affordable ideas that will help them build machines and recycle plastic and put it towards a good use.

complete package

The Can Itself

What are the initial dimensions of the can?

- Height = 123mm high
- Width = 66.04mm diameter

How big must the can crusher be in order to accept a new can?

- The spot to be crushed at should be about 4.9” high and 2.65” wide, and the slit to exit should be 1.4” wide

How much must the can be crushed to achieve a 50% reduction in volume?

- It really depends on the can (shape and size). But for a can to achieve 50% reduction rate. The can must be half crushed. (Volume/2)

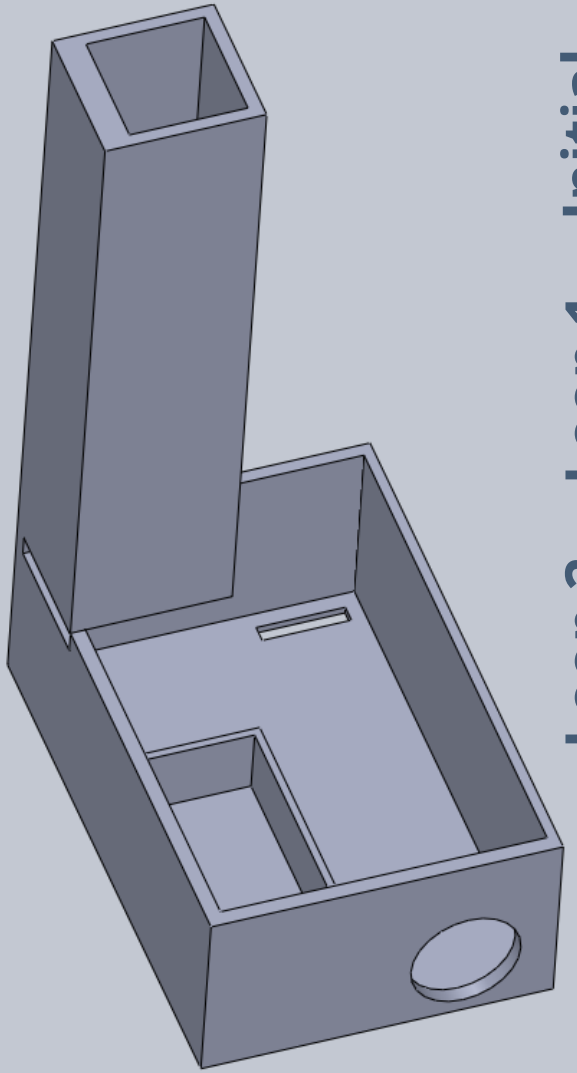
How much force must be applied to the can to crush it by 50%?

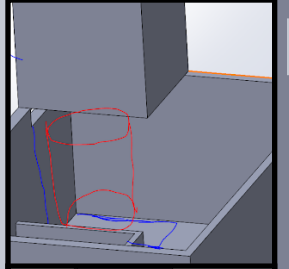
- It takes 250 lbs of force to crush a can 50% or over horizontally.
- It takes 60 psi only to crush vertically

Would denting the can help crushing it?

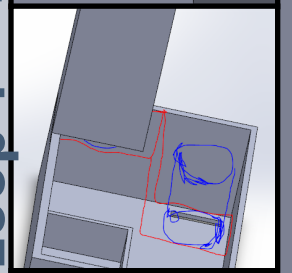
- Yes, but only if you were to crush it vertically

Brainstorming Solutions

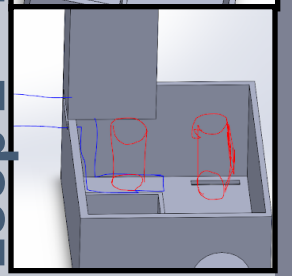




Initial



Loop 1



Loop 2

Idea #1

How it Works:

1. A can falls down a vertical drop into a motorized pusher
2. The motorized pusher takes the can from under the dropoff to the spot to be crushed, while the top of it holds the rest of the cans up
3. After the can has been crushed, the pusher comes back, while the can goes down the slit
4. Then the process keeps repeating for as long as there is a can sensed in that position

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Idea #2

How it Works:

1. The cone shape allows the can to go through and the narrower the edge gets, the more straight the can gets; steel is preferrable

2. The can fells right down in order to be crushed while holding the other can up

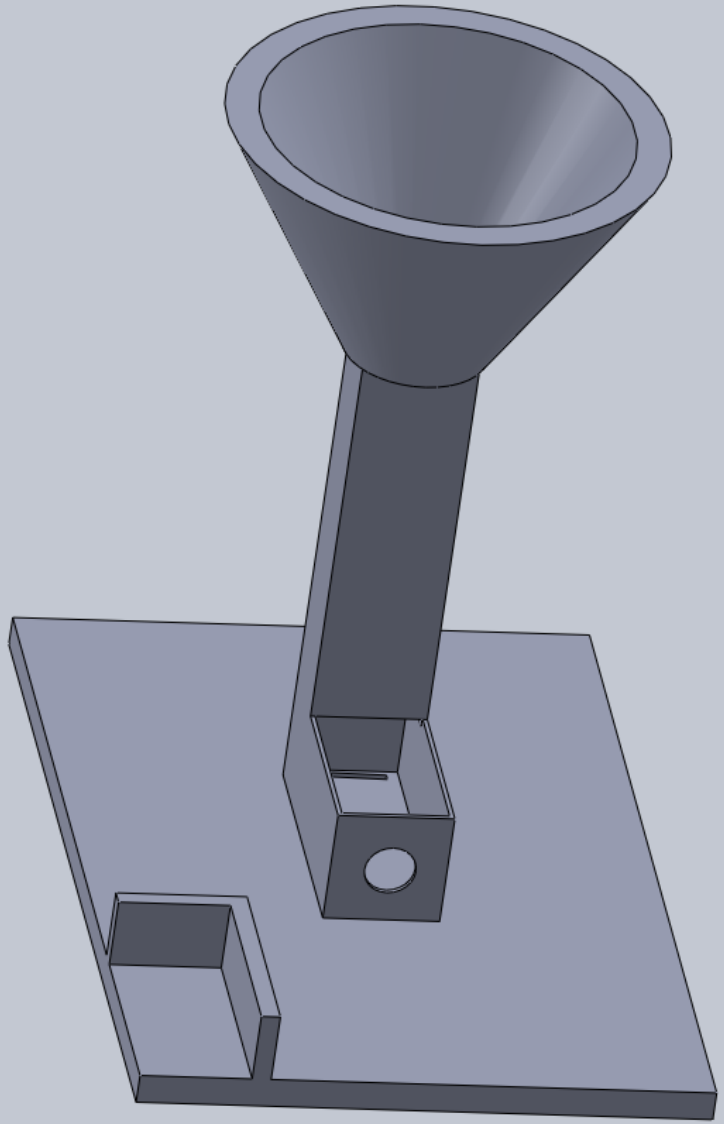
Loop Starts

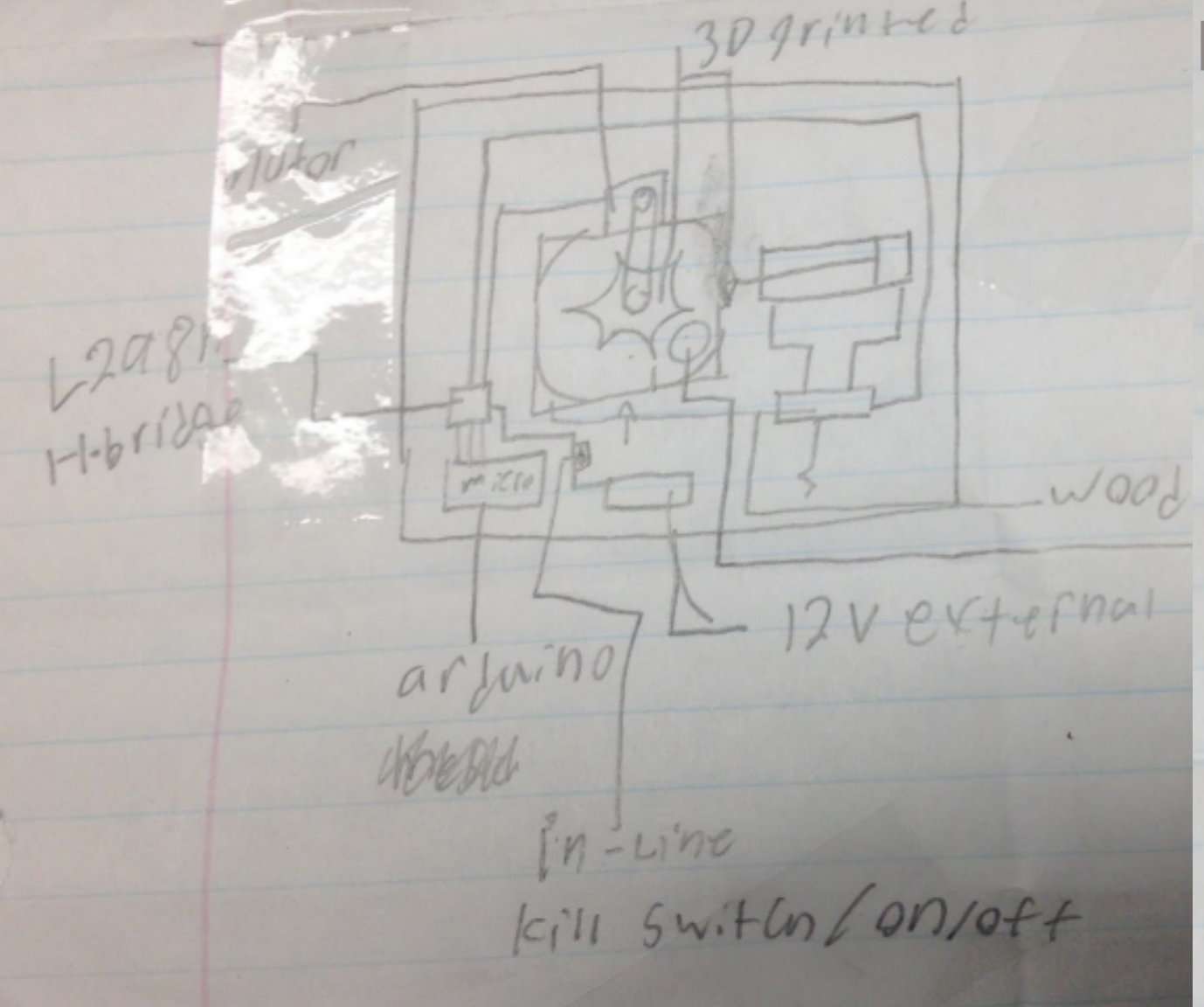
1. As soon as the pusher comes to crush, it's elegant shape similar to Idea#1 holds the other cans up

2. When piston retracted, the slanted shape on the top of the pusher lets the can on top to slide down into crushing position

Loop Ends

1. How to stop when no can present:
    a. Optical sensor embedded in the side wall which has reduced sensitivity, and when a can falls through it sends a signal to Arduino to push the solenoid and after it retracts, Arduino checks with another sensor if the can fell through or not.

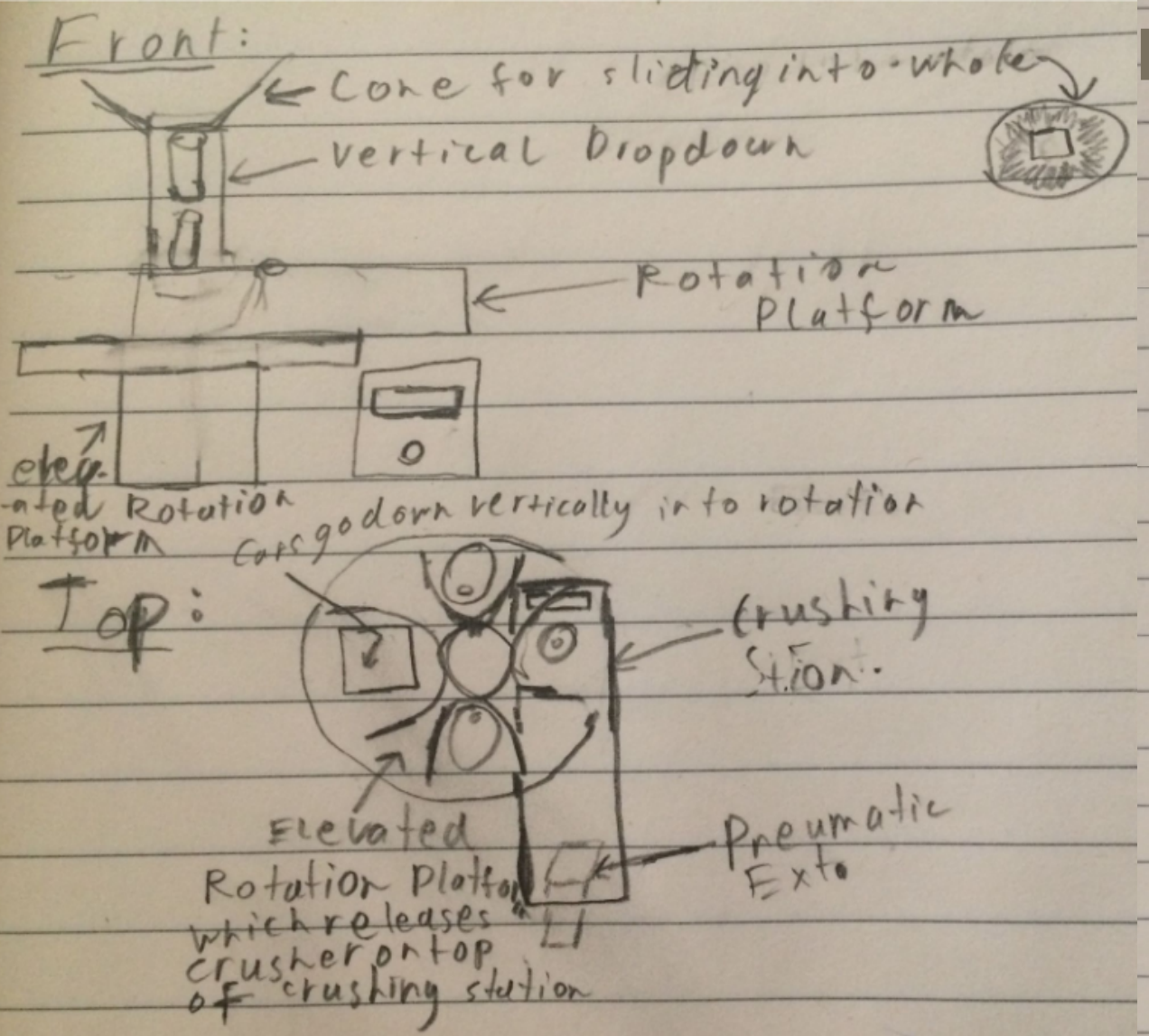




Idea #3

How it Works:

1. Cans are filled up in can holders, being rotated by a center piece connected to a motor
2. After the can has moved in front of the pneumatic extension it will be crushed by a concave shaped face, so that the discs of the can bend in toward the can
3. The can exits through a hole which is placed above a recycling bin
4. The process keeps repeating as long as it senses a can in the spot before being placed in front of the pneumatic arm

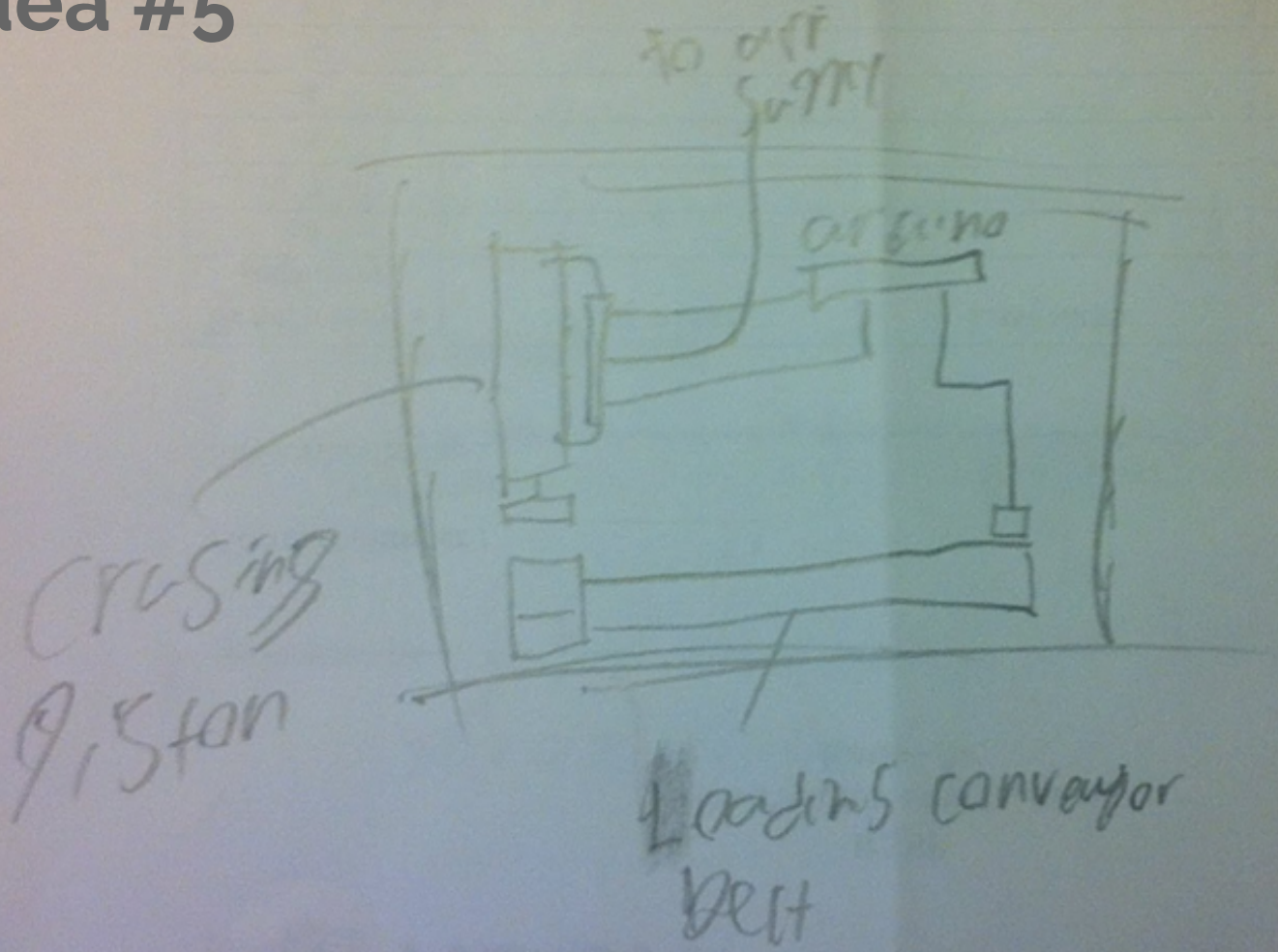


Idea #OVERKILL

How it Works:

1. A can slides through a cone to fall down a vertical drop into a motorized rotational machine which is placed on an elevated platform
2. A motor rotates a middle piece which has 4 can holders around it, that have the job of taking the can from under the verticle dropdown to above the crushing station
3. As soon as the can has rotated to right over the edge of the elevated rotation platform, it will fall vertically to a place to be crushed
4. After the can has been crushed, the pneumatic extension comes back, while the can goes down the slit
5. Then the process keeps repeating for as long as there is a can sensed in that position

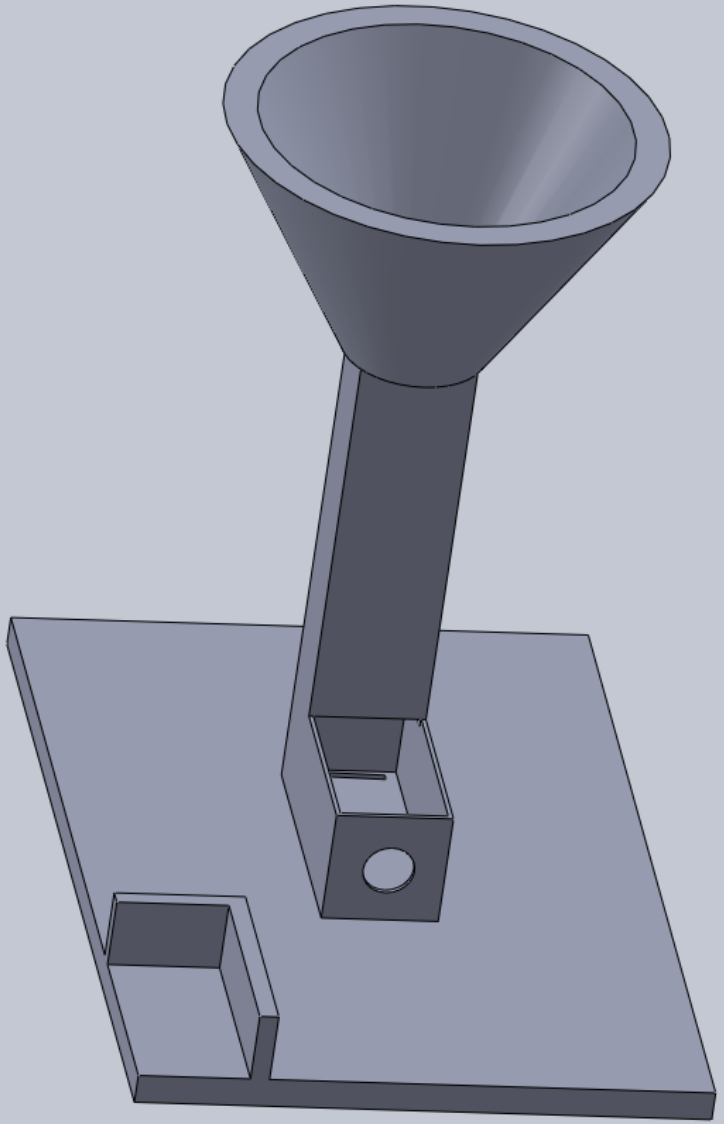
Idea #5



How it Works:

1. A can is carried across a conveyer belt to infront of the pneumatic arm
2. Once a can is sensed in front of the arm it extends, and the conveyer belt stops
3. If the sensor doesn't sense anything for a whole rotation of the conveyer belt, the program ends

Choosing Best Solution



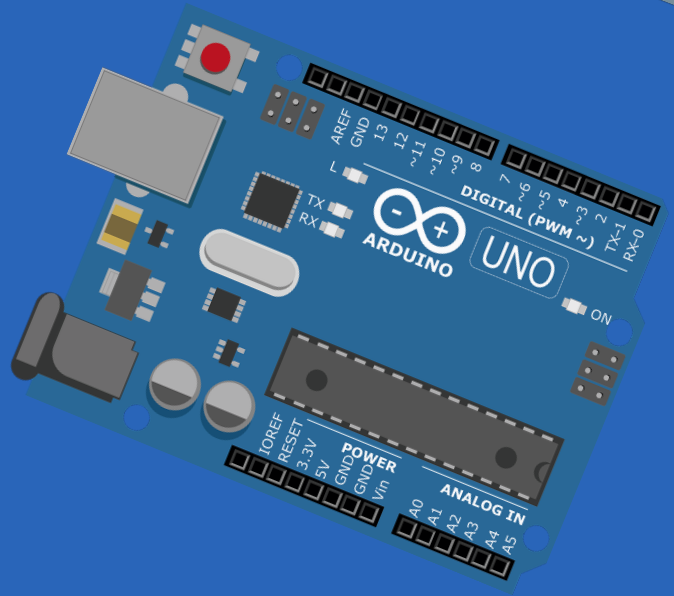
Why?

The idea of having a cone which would be assigned to accept a can thrown from any direction into a vertical position adds practicality, originality, and culture to the prototype. This design embodies Canada's culture by signinfying the phrase, "Shootin' them hoops!"

This design is also much more simple and energy efficient compared to the other designs. It is best put in words of our team's structural engineer, "It can be simplified as long as there are any moving parts." We chose to utilise the nature's force, "Gravity".

Sensors are also used in the most efficient way to add safety to this plan. The Arduino programming is the most complex part of this design, and our organization has talented programmers to encounter these problems.

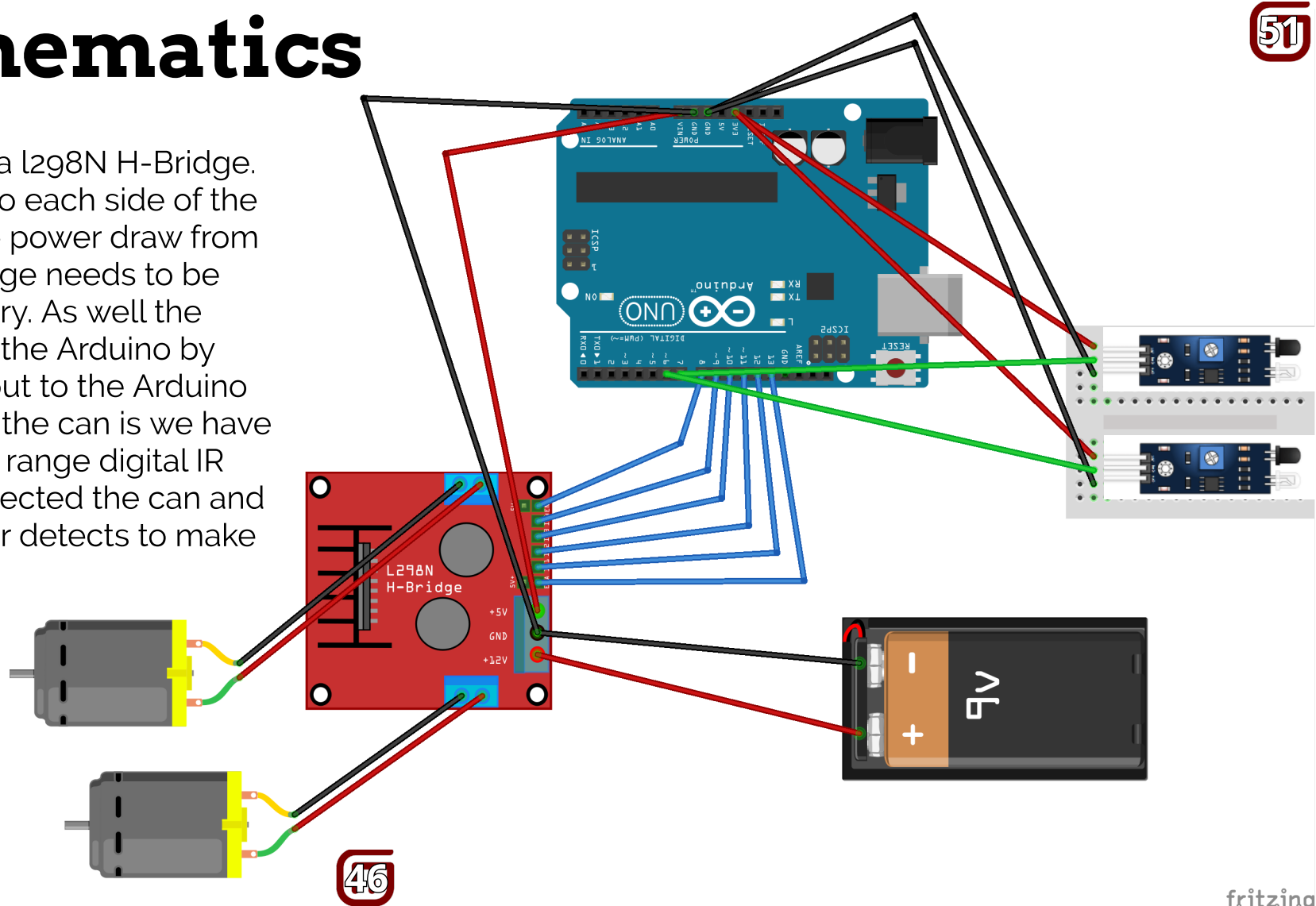
After looking at all designs, their cons and pros, this design was the most reasonable to accomplish in this time limit.



Developmetal Work

Arduino Schematics

An Arduino is connected to a l298N H-Bridge. this H-Bridge is then connected to each side of the solenoid, because of the massive power draw from the solenoid actuator. The H-Bridge needs to be powered by an external 12V battery. As well the H-Bridge is backwards powering the Arduino by connecting the 5v out and GND out to the Arduino 5v and GND pins. To know where the can is we have two close range TCRT5000 close range digital IR sensor modules, one module detected the can and causes the piston to fire, the other detects to make sure the can has been crushed.



Exceptions:

- Motors substituted for actuator coils
- 9V Battery Substituted for 12v

Explanation

Steps:

I. A power source is connected directly to the H-Bridge, which has the job of powering the Arduino, and two valves on the pneumatic actuator.

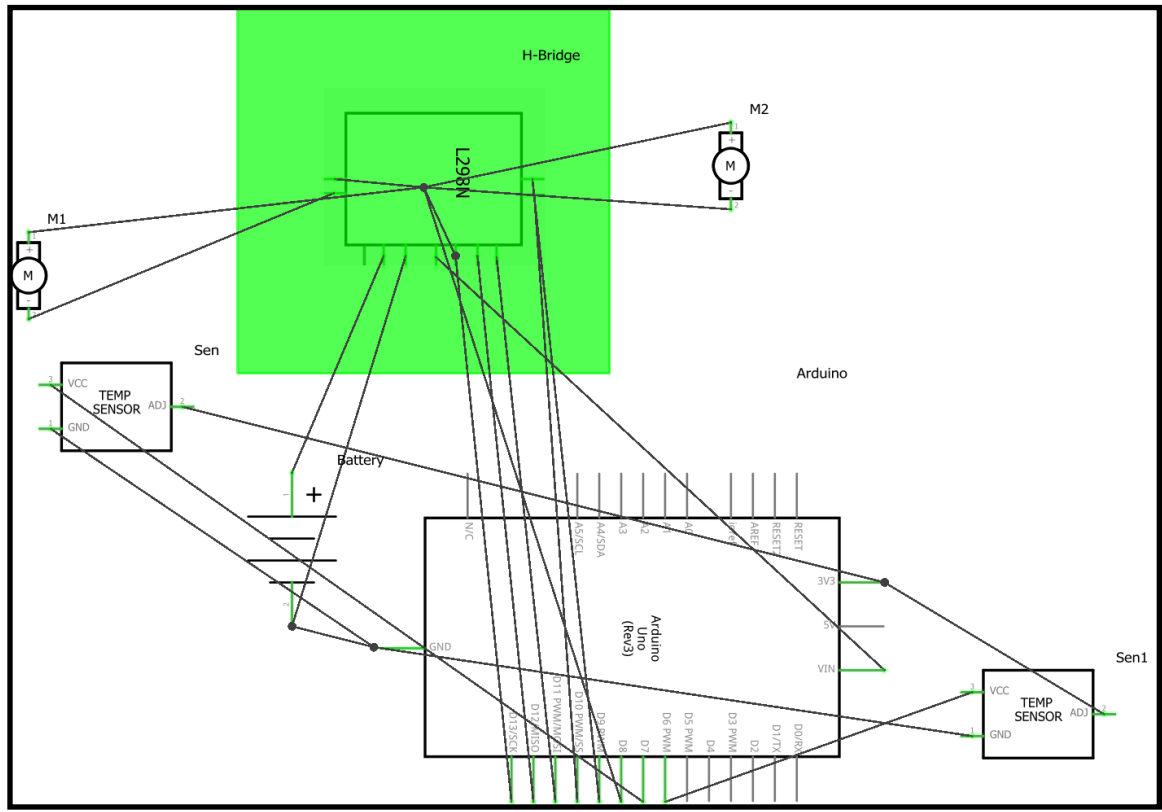
II. The 'Sen' sensor is placed right beside the can's landing place, and sends an input signal to the Arduino, which sends a power signal to the H-Bridge to extend pneumatic piston

III. Retracts after a certain delay; amount of time it takes to crush can

IV. Meanwhile, 'Sen1' sensor starts looking if a can fell through the ejection system or not

V. Once 'Sen1' finds a can that exited the system, it goes back to see if 'Sen' senses a can that is there to crushed

The loop continues

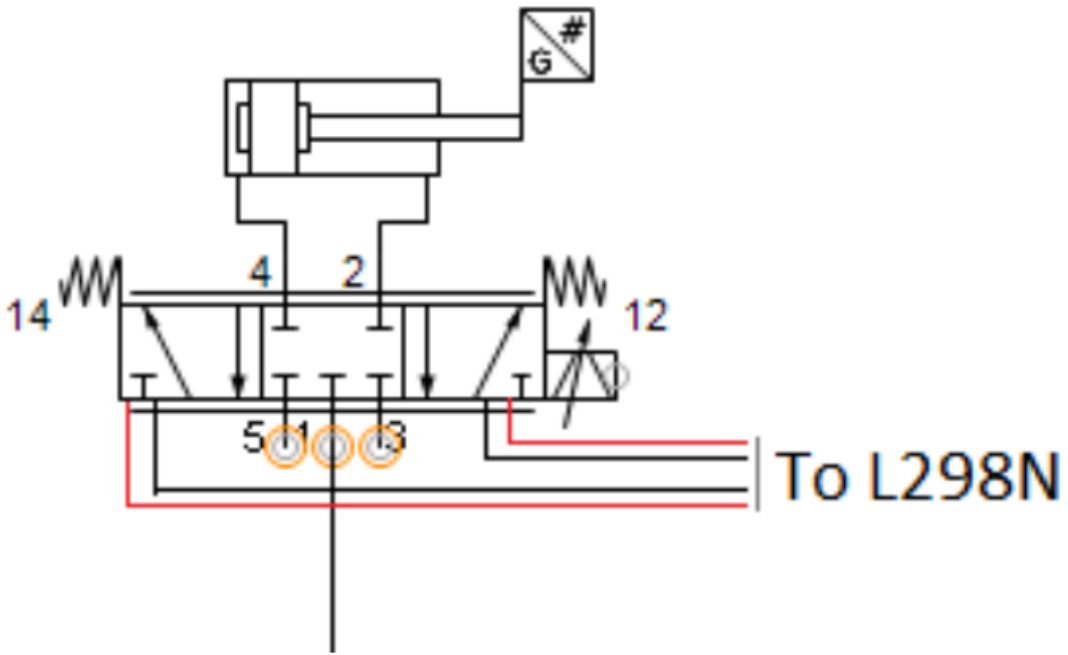


Arduino Code File

```
//Solenoid Off
int enA = 13;
const int in1  = 12;  // Pin 14 of L293
const int in2  = 11;  // Pin 10 of L293

//Solenoid On
int enB = 8;
const int in3  = 10; // Pin  7 of L293
const int in4  = 9;  // Pin  2 of L293

//Sensors
int sen1 = 7;
int sen2 = 6;
int oof = 0;

//E-Stop
const byte interruptPin = 2;
int STOPPED = 0;

void setup(){
  //Set pins as outputs
  pinMode(in1, OUTPUT);
  pinMode(in2, OUTPUT);
  pinMode(in3, OUTPUT);
  pinMode(in4, OUTPUT);
  pinMode(sen1, INPUT);
  pinMode(sen2, INPUT);
  pinMode(enA, OUTPUT);
  pinMode(enB, OUTPUT);

  Serial.begin(9600); //Debug
  backward();

  int valL = digitalRead(sen1);

    if (valL == HIGH){
        delay(100);
        forward();
    }

  delay(5000);
  backward();

  //E-stop Settings
  //attachInterrupt(digitalPinToInterrupt(interruptPin), stop, HIGH);
}

void loop(){
  if (STOPPED == 0){

    int valL = digitalRead(sen1);
    int valR = digitalRead(sen2);

    while(oof == 0){
      int valR = digitalRead(sen2);

      if (valR == HIGH){
        oof = 1;
        Serial.println(oof); //Debug
        break;
      }
    }
```

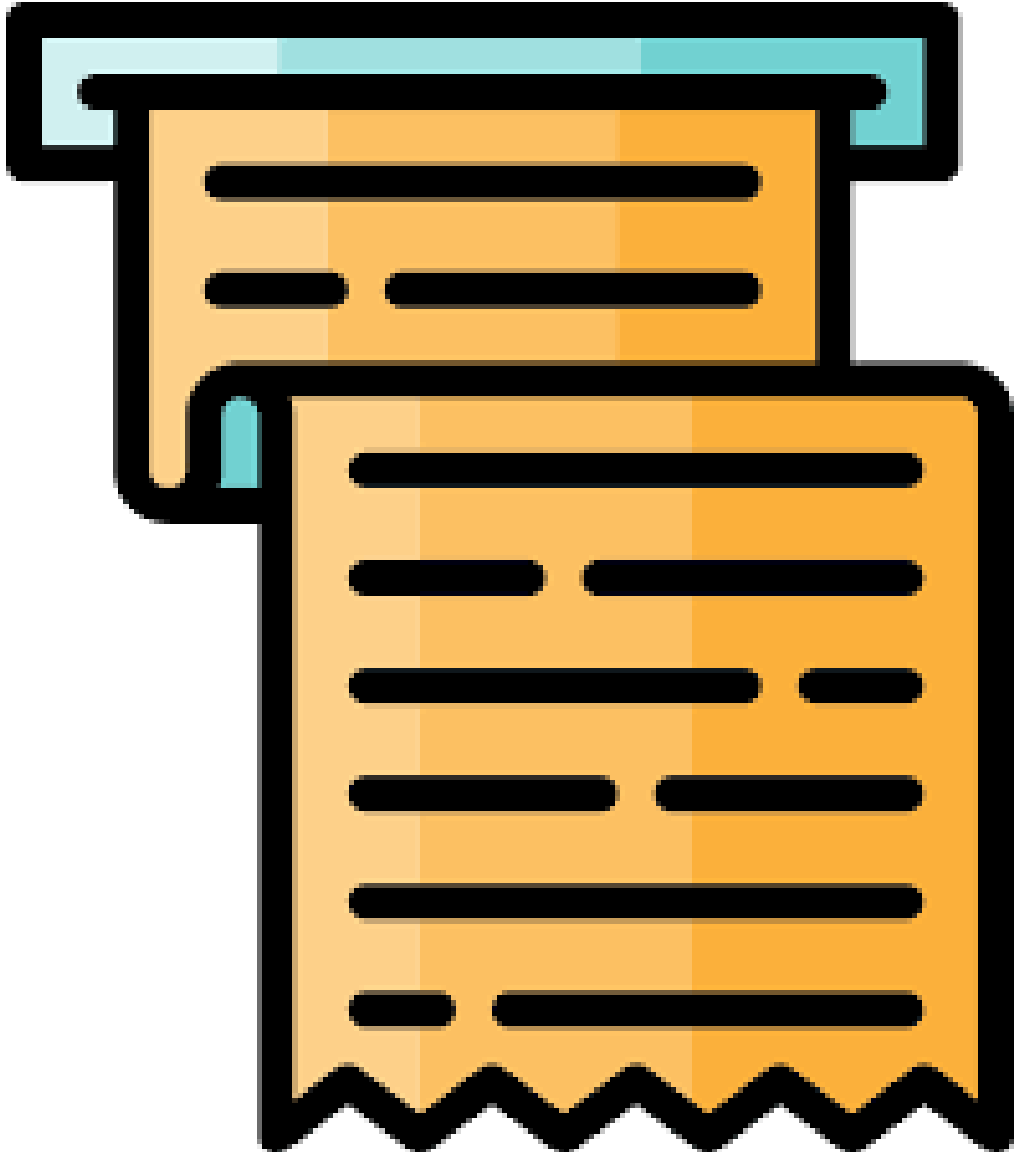
```
    delay(100);
    off();

    if (valL == HIGH){
        if (oof == 1){
          delay(500);
          forward();
          oof = 0;
          Serial.println(oof); //Debug
        }
    }
    delay(5000);
    backward();
  }
}

void forward(){
    digitalWrite(in1, HIGH);
    digitalWrite(in2, LOW);
    digitalWrite(in3, HIGH);
    digitalWrite(in4, LOW);

    analogWrite(enA, 0);
    analogWrite(enB, 255);
}

void backward (){
    digitalWrite(in1, HIGH);
    digitalWrite(in2, LOW);
    digitalWrite(in3, HIGH);
    digitalWrite(in4, LOW);

    analogWrite(enA, 255);
    analogWrite(enB, 0);
}

void off (){
    digitalWrite(in1, HIGH);
    digitalWrite(in2, LOW);
    digitalWrite(in3, HIGH);
    digitalWrite(in4, LOW);

    analogWrite(enA, 0);
    analogWrite(enB, 0);
}

/*
void stop(){
  backward();
  STOPPED = 1;

  analogWrite(enA, 0);
  analogWrite(enB, 0);

  //digitalWrite(LED, HIGH);
}
*/
```

Pneumamtic Schematic



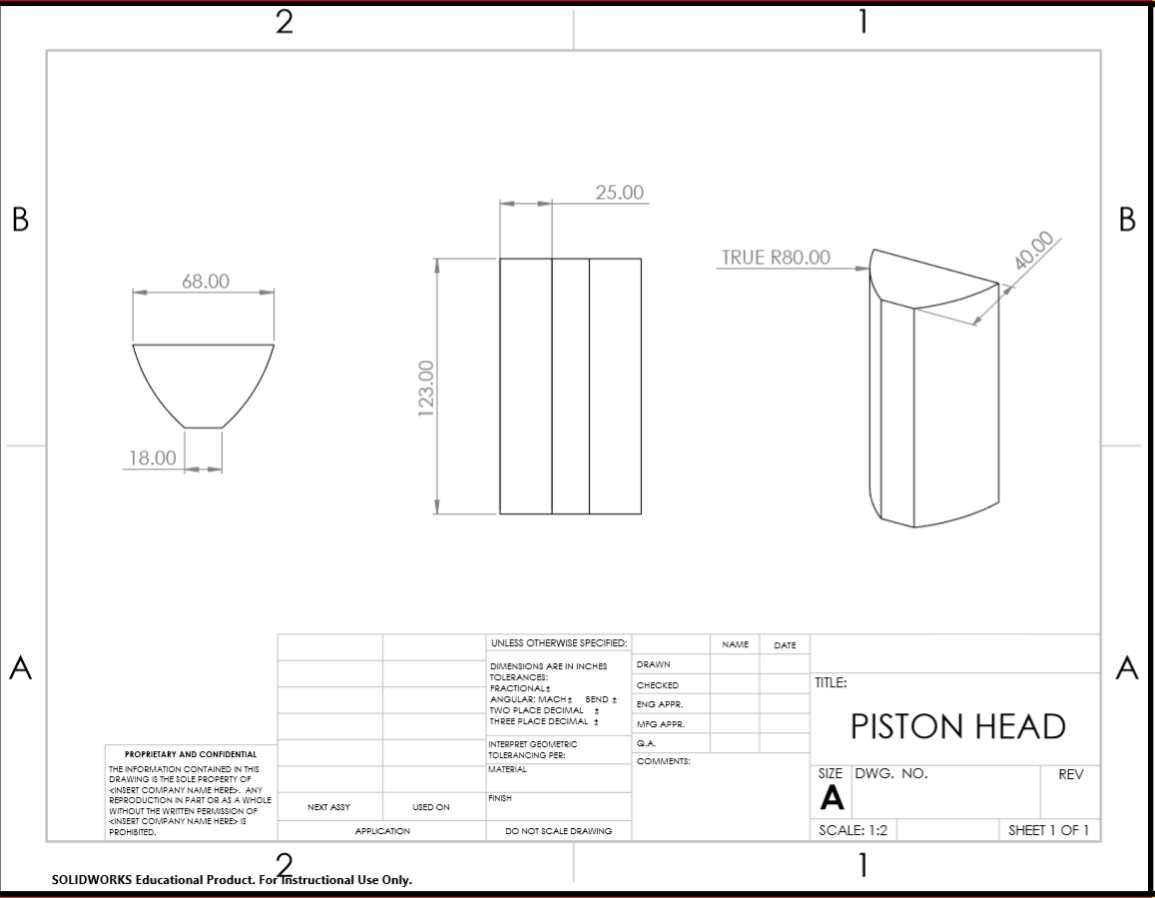
Explanation:

For the pneumatics, it is a simple circuit with an air supply coming into the Solenoid and two air hoses connecting to the pneumatic piston. When one of the sides of the Solenoid receives power it powers an electromagnetic coil. When the electromagnetic coil is powered it pushes a rod which activates one of the Pneumatic “gates”, that allows for the air to flow in/out of the piston allowing it to be able to extend or retract (crush the can).



Bill of Materials

1. 2 Alligator clips: $0.30 - $0.50 each
2. 12v battery: $18.00 - $100.00
3. LED switch: $10.00 - $20.00
4. Flag Push connectors: $20.00 - $50.00
5. Battery enclosure $130.00 - $800.00
6. Push button: $5.00 - $25.00
7. Micro USB: $2.00 - $10.00
8. Arduino Uno: $7.00 - $30.00
9. Prototyping board: $17.41
10. L298N H bridge $2.70
11. Pneumatic piping (25 meter) $18.50
12. Quick connect valves $22.50
13. Solenoid actuator $80
14. Piston $52.88
15. 1 Spool 3d printing plastic $20
16. Mini breadboard $5.14
17. TCRT 5000 module $1.30
18. 370-pack screw bolts $6.76
19. Wood $53
20. Acrylic Plastic $45
21. L-Supports $2
22. Malleable Metal Braces $18
23. Filament Tape Roll $30
24. Masking Tape Roll $15



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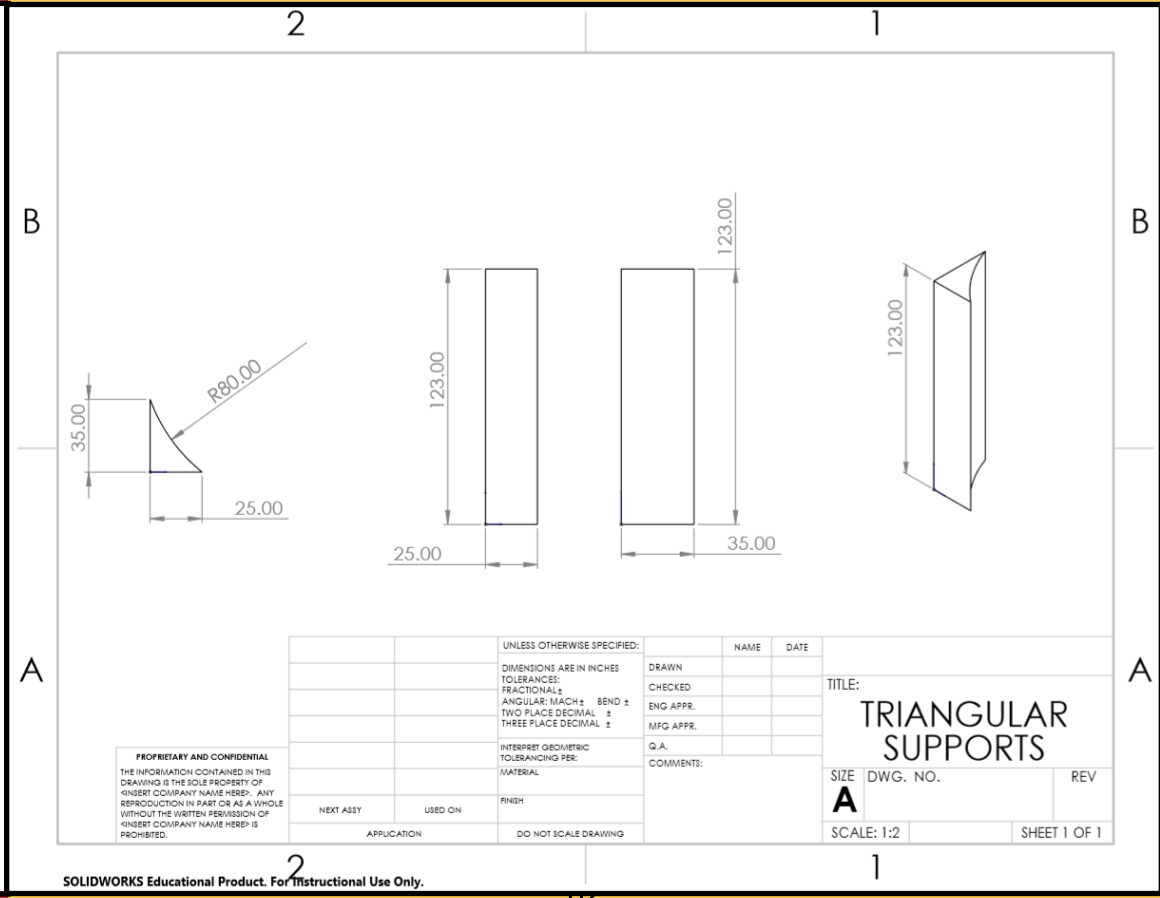

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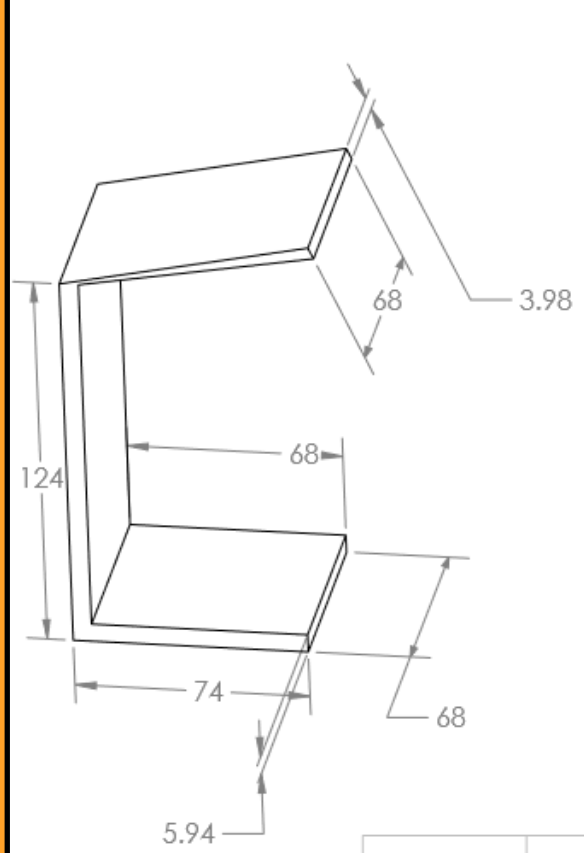
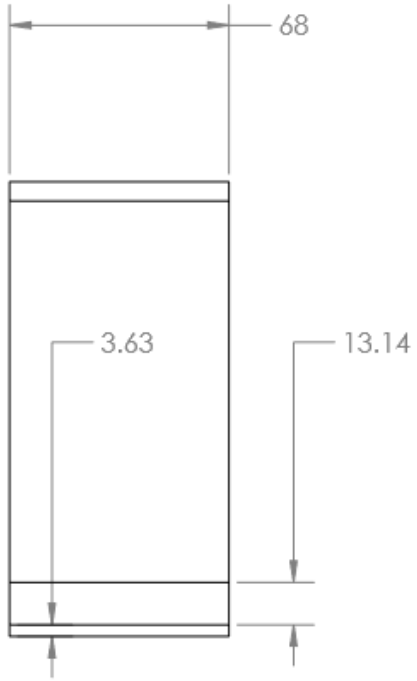
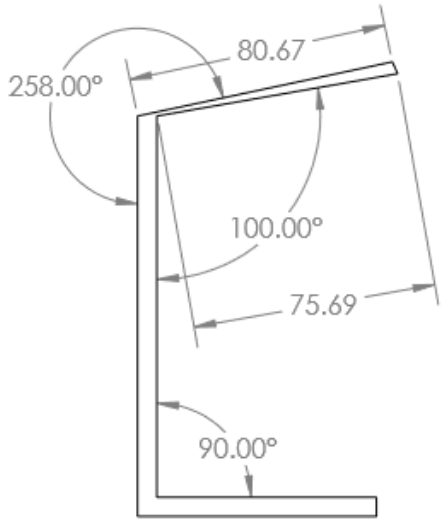






		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

TITLE:

Can Crushing Extension

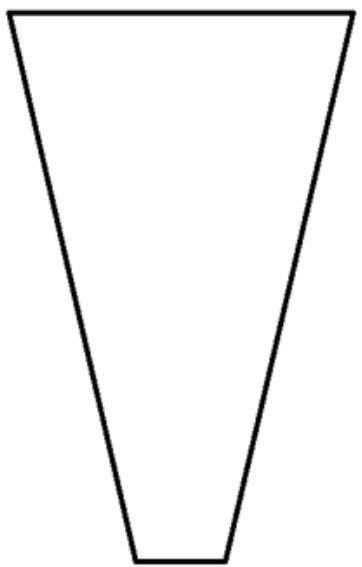
SIZE	DWG. NO.	REV
A		

SCALE: 1:2	WEIGHT:	SHEET 1 OF 1

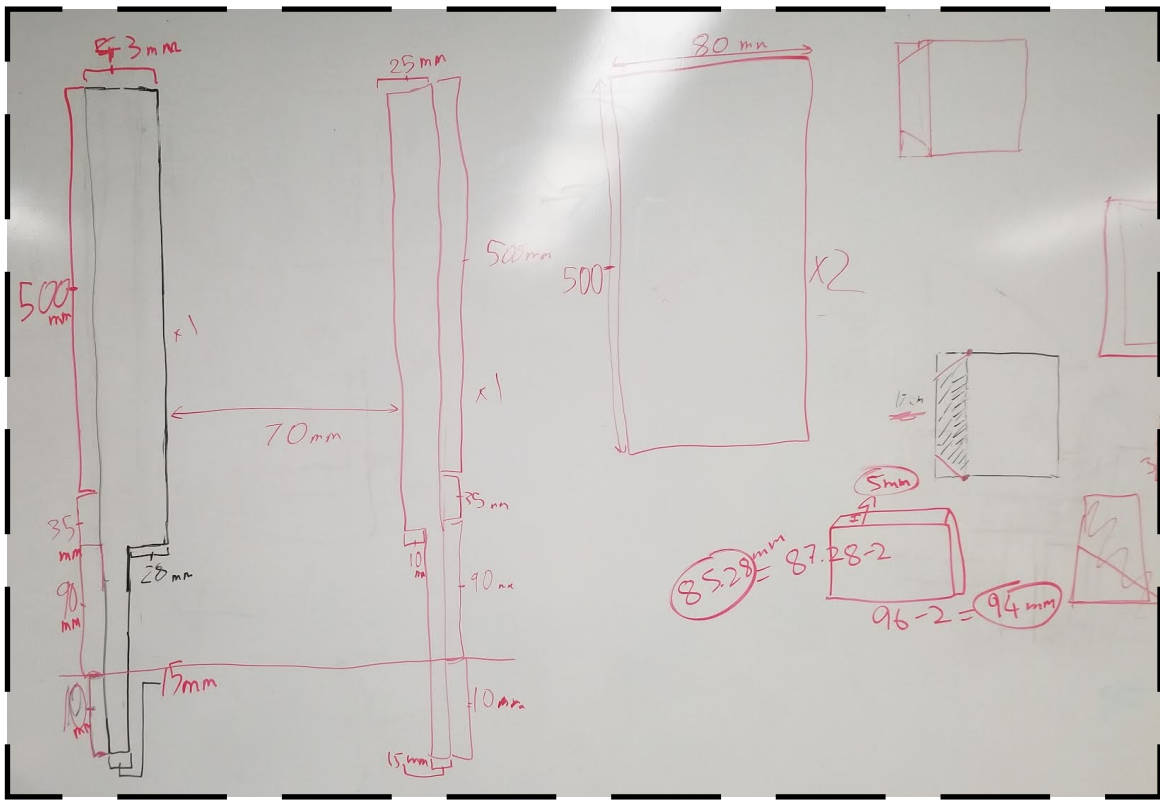
Calculations

Polygon Circular Piece Measurements (For Cone):

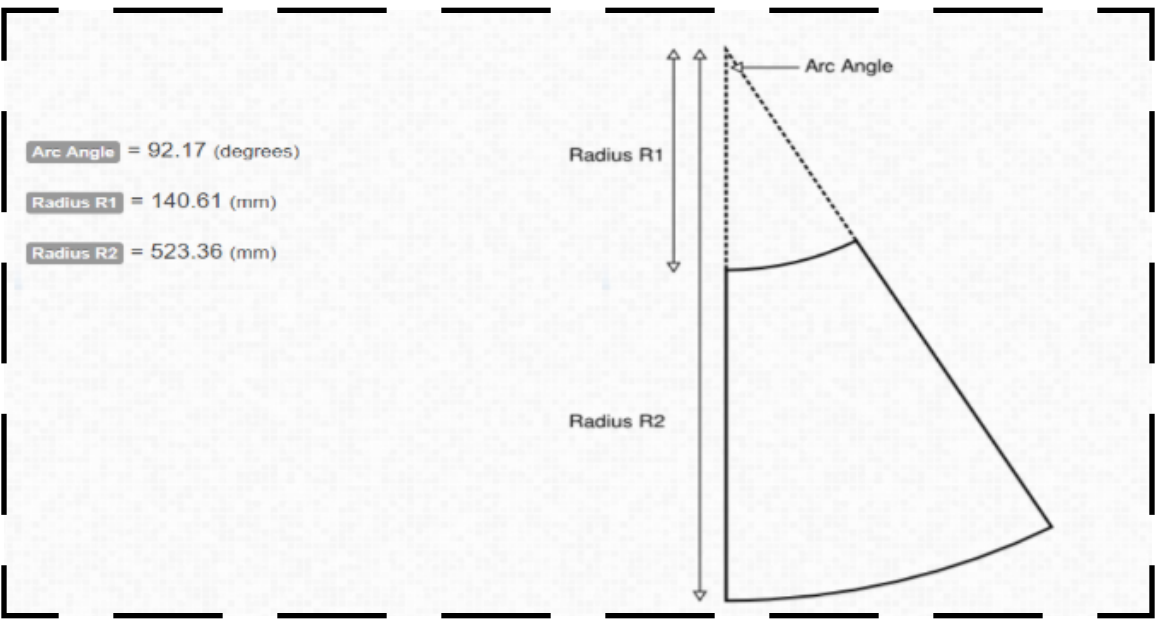
- 4 cans wide, 3 cans length(not height)
- Circumference: 842 mm, 220 mm
- 8 polygon pieces
- Upper Line Length: 105.2
- Bottom Line Length: 27.5



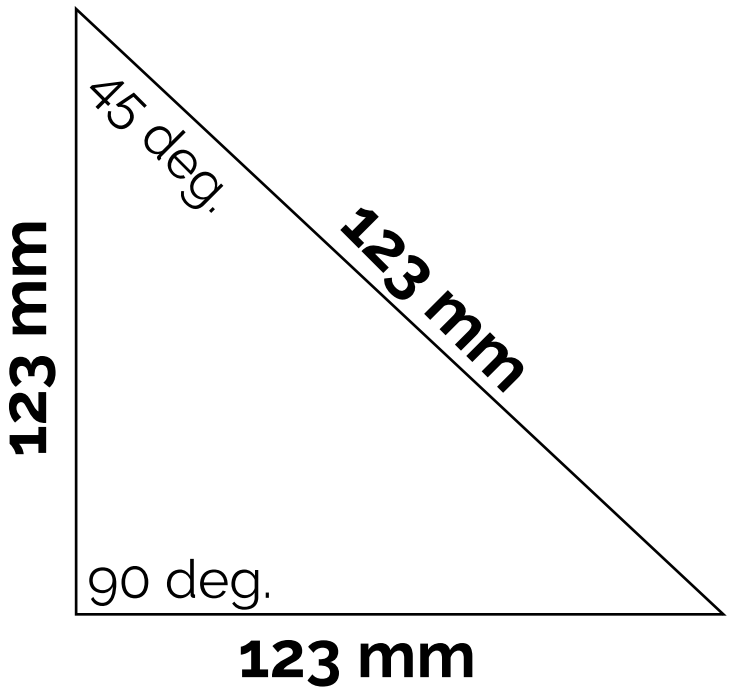
Side Walls & Wedges:



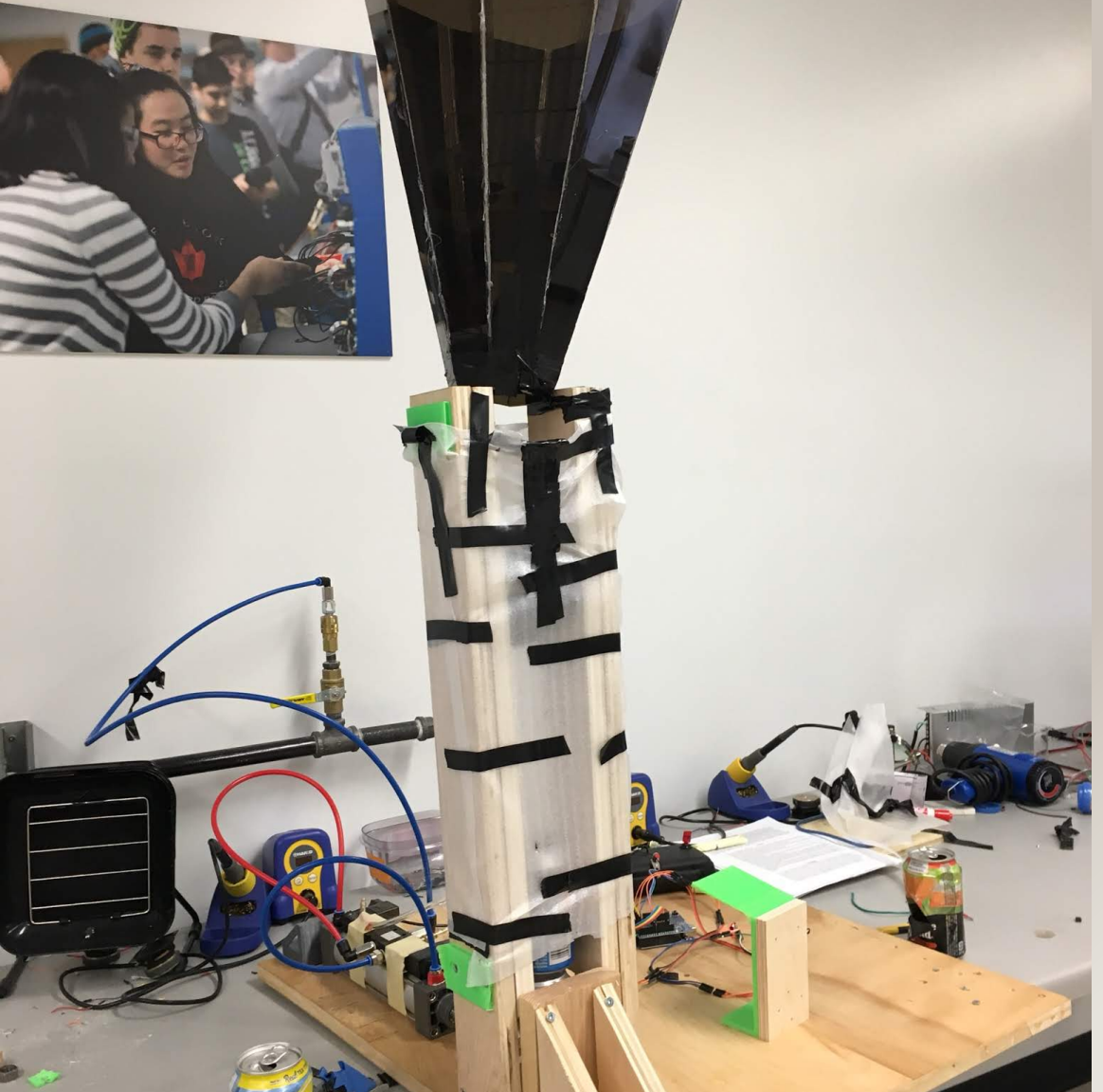
If Cone was made out of Sheet Metal:



Triangular Supports:

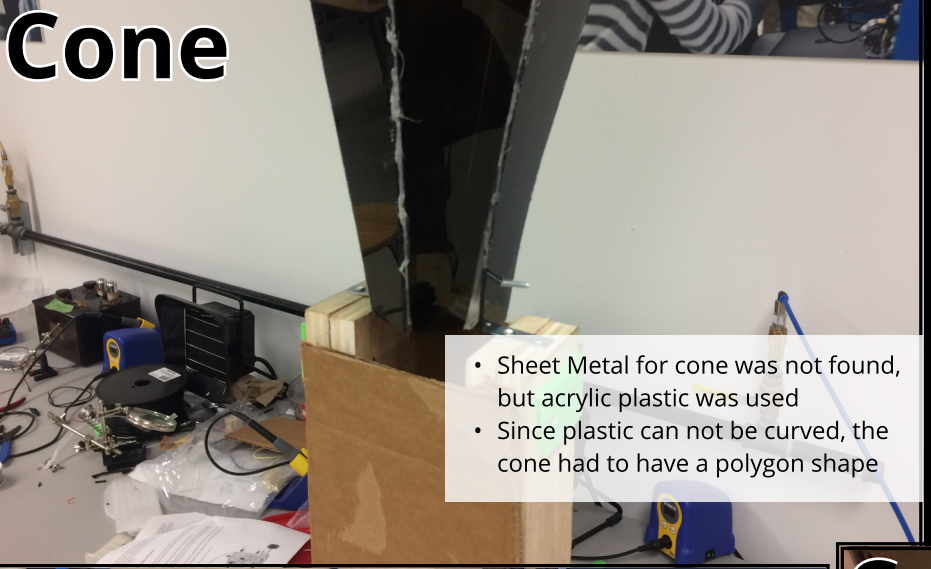


Sin45 = 1



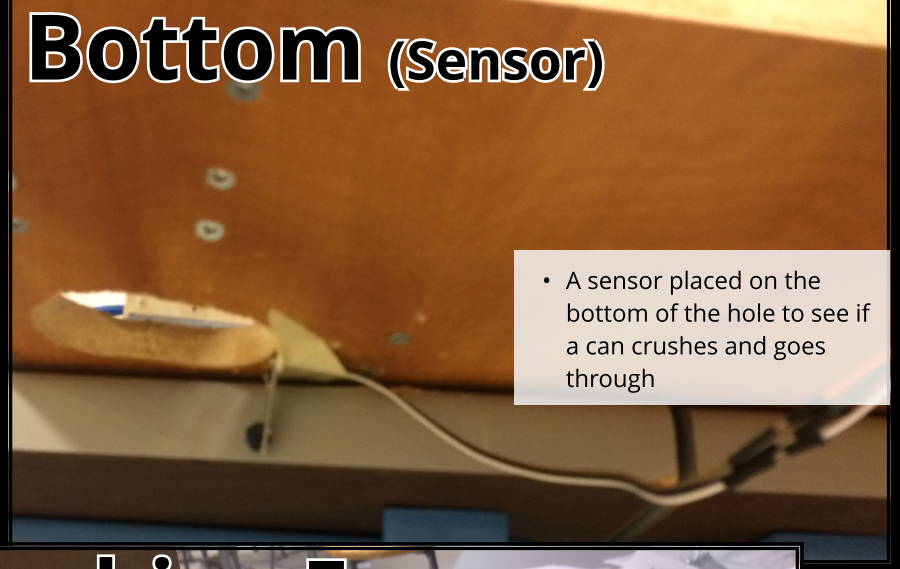
Constructing A Prototype

Cone



- Sheet Metal for cone was not found, but acrylic plastic was used
- Since plastic can not be curved, the cone had to have a polygon shape

Bottom (Sensor)

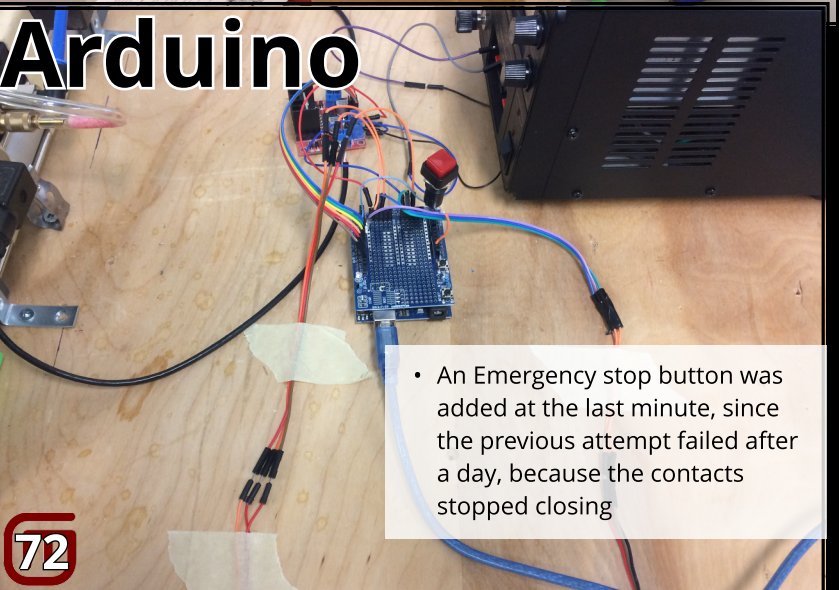


- A sensor placed on the bottom of the hole to see if a can crushes and goes through

Can Holder

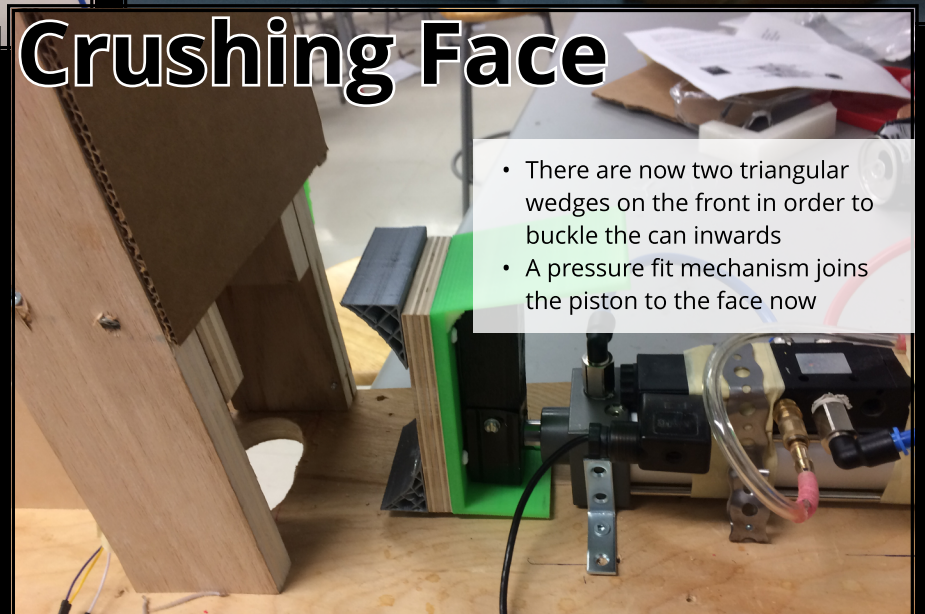
- Able to Hold 5 cans now

Arduino



- An Emergency stop button was added at the last minute, since the previous attempt failed after a day, because the contacts stopped closing

Crushing Face

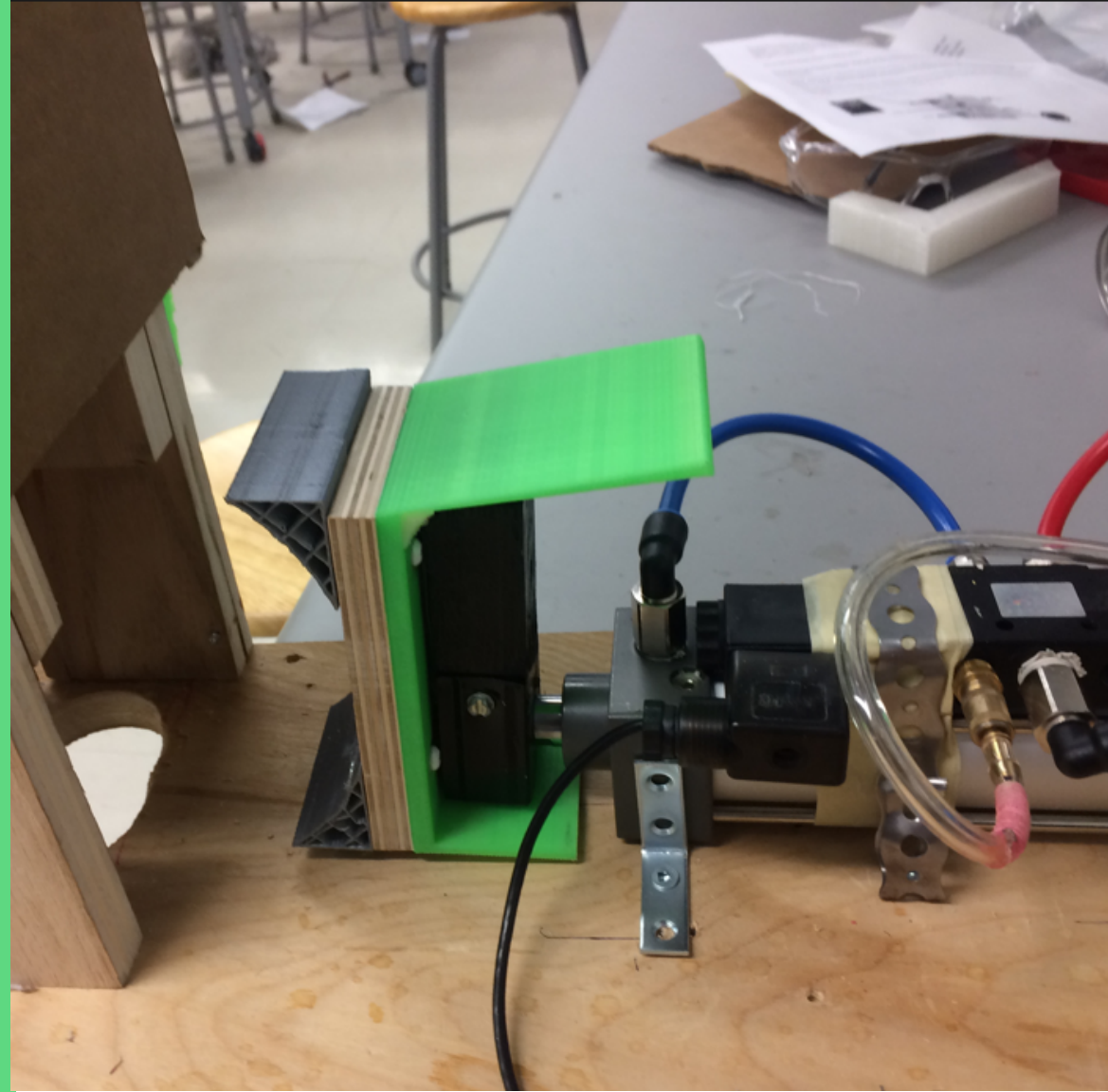


- There are now two triangular wedges on the front in order to buckle the can inwards
- A pressure fit mechanism joins the piston to the face now

Back (Supports)

- Triangular supports were added for structural support to prevent any wood snapping
- Recycled 3d printed used for enclosing gab betweed cardboard and wood

Testing & Evaluation



Can Feeder Mechanism

Test Passed

Can sent down in any orientation gets straightened to a vertical position

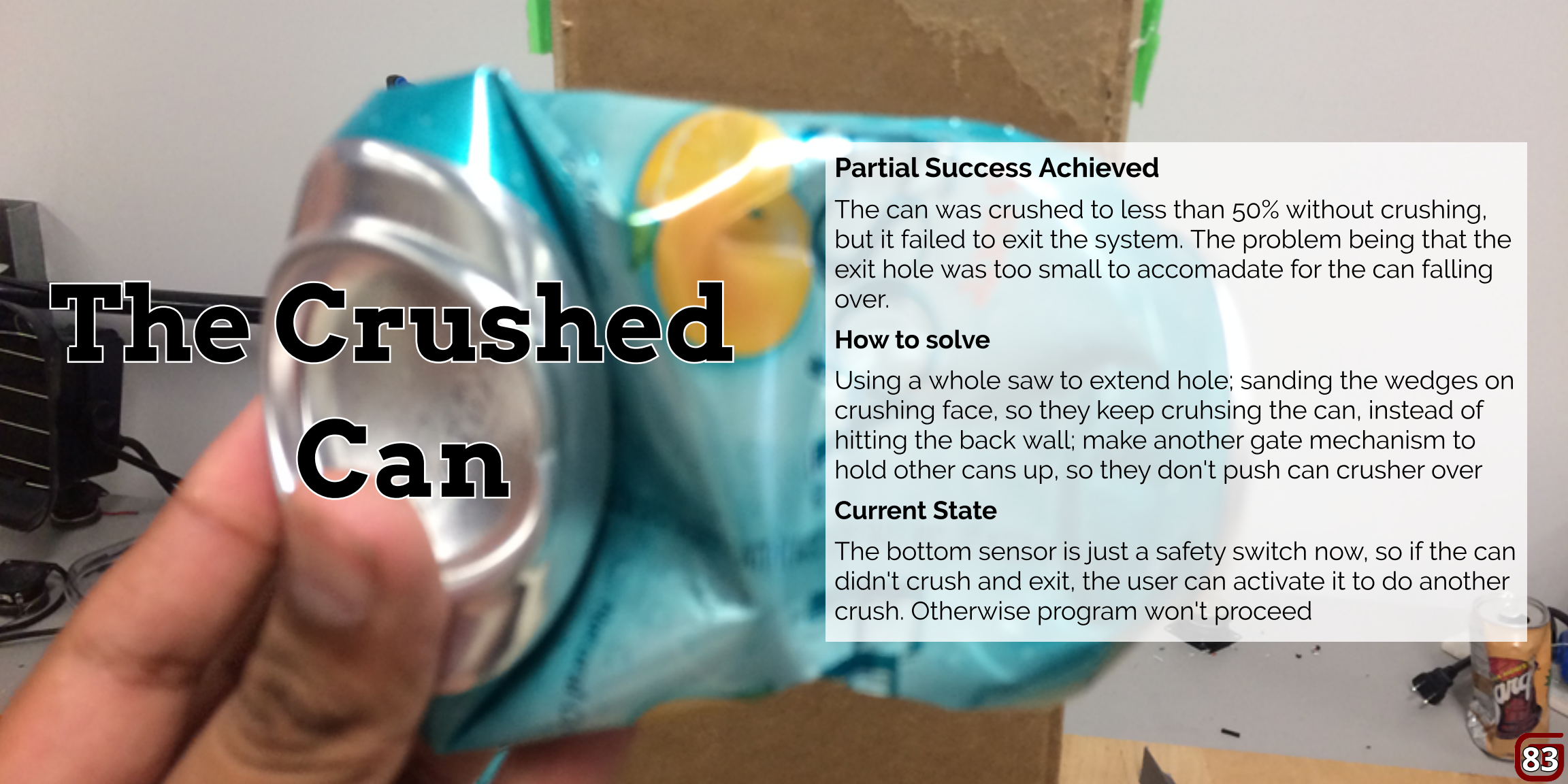
Attempt #1

A curved face going against a vertical can does not work as it is not putting any force on the discs which need to be buckled in

Attempt #2 ✅

This design works as the wedges on the top and bottom of the face bend the discs inwards

The Crushed Can



Partial Success Achieved

The can was crushed to less than 50% without crushing, but it failed to exit the system. The problem being that the exit hole was too small to accomadate for the can falling over.

How to solve

Using a whole saw to extend hole; sanding the wedges on crushing face, so they keep cruhsing the can, instead of hitting the back wall; make another gate mechanism to hold other cans up, so they don't push can crusher over

Current State

The bottom sensor is just a safety switch now, so if the can didn't crush and exit, the user can activate it to do another crush. Otherwise program won't proceed

Problem Solving

The Emergency kill switch was not responding

Used interrupt pins (ignores delays)

Woodworking Pieces kept getting used by other people

Created new ones and stored them safely

Arduino was not turning on

Made more stable wire connections

Second sensor was getting ignored

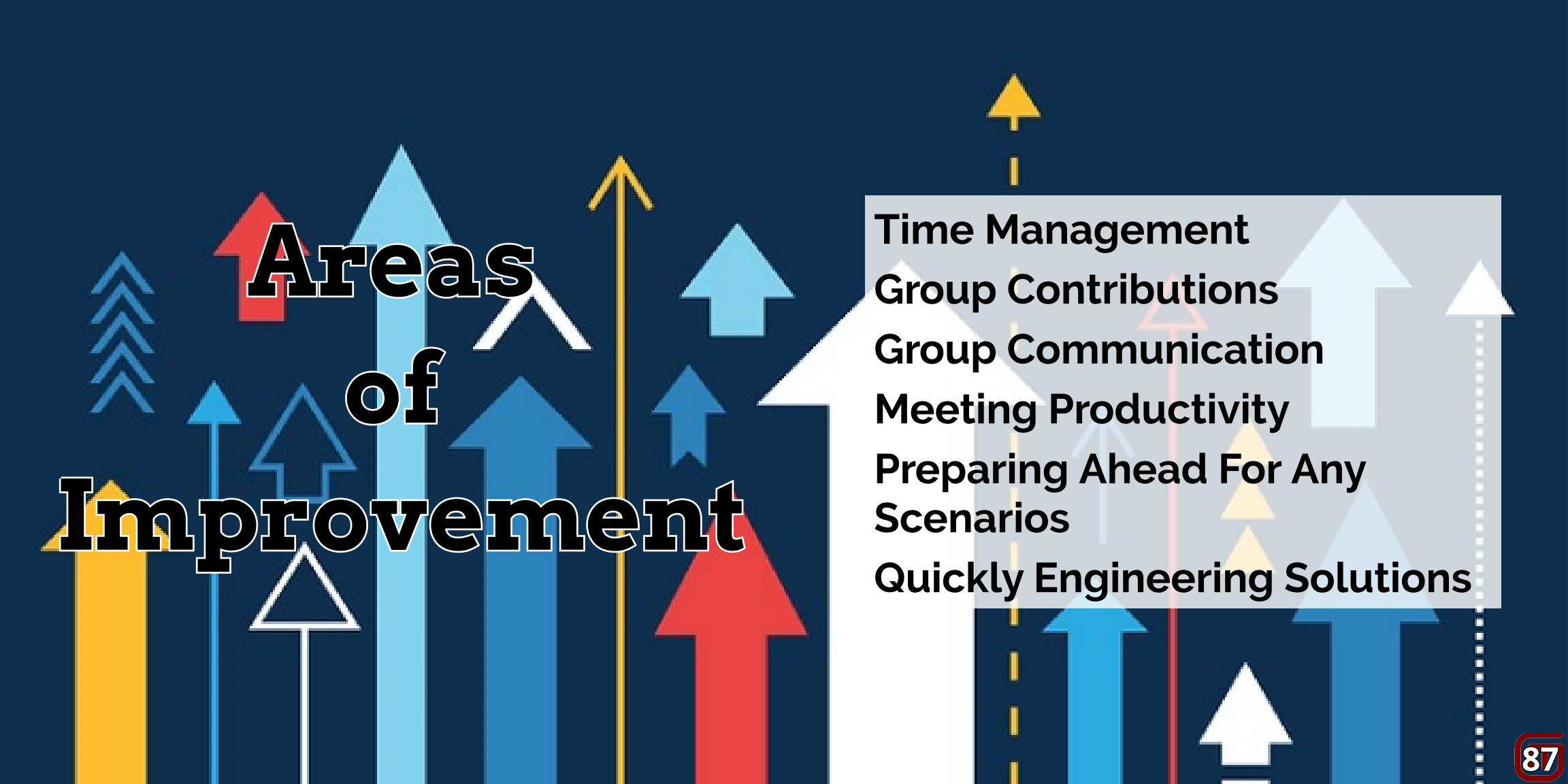
Put it in a (while) loop and it breaks once can exits

The piece connecting the piston to the face snapped in half due to it's small size and pressure applied

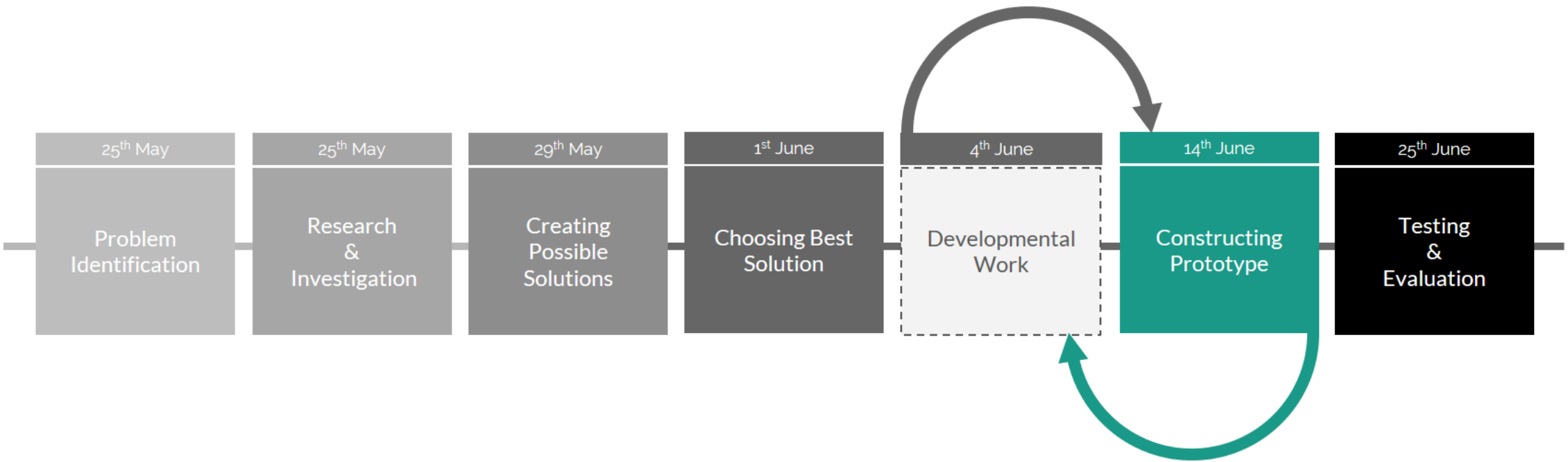
Made a larger piece with a more tight and secure connection

The pneumatic cylinder was not stable in it's position

Used L-Supports to pressure fit the piston


Areas of Improvement
Time Management
Group Contributions
Group Communication
Meeting Productivity
Preparing Ahead For Any Scenarios
Quickly Engineering Solutions

Timeline


25th May
Problem Identification
25th May
Research & Investigation
29th May
Creating Possible Solutions
1st June
Choosing Best Solution
4th June
Developmental Work
14th June
Constructing Prototype
25th June
Testing & Evaluation

Citations:

Research Citations:

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Samuel Hassan Darion Kindred