CUBE

PRE-ENGINEERING CAN CRUSHER FINAL

Rafi, Isaiah and Carson

CUBE

1) The CUBE

We are a group of Bedford Road Pre-Engineering 10 students that are working on their final project, to create a can crusher capable of reducing the size of a can by 50%. Throughout the semester we worked efficiently to end up with the best can crusher yet!

LOGO

Our logo is symbolic of a cube because no matter what you can only see 3 sides at a time. Hence our group of only three may leave us handy-capped in terms of time but we can collaborate much more efficiently and bring our own unique skills to the challenge.

2) Team Members and Roles

Although we effectively worked together as one essence, there were specific roles for the different members.

Rafi: Electronics, Documentation, Construction, Thinking and Espionage

Isaiah: Documentation, Construction, Thinking and Entetainment

Carson: Construction, Electronics, Planning and Reality Checks

3) The Challenge

The CUBE has been tasked with the challenge of designing and producing a working prototype of a can crusher. With both time and resource constraints, our process has been interrupted by many problems. In our design, we use a pneumatic cylinder, micro controller, rotating system and solenoid valve to crush to 50% of the original size. All while following the design constraints:

Have at least one piece manufactured by the 3D printer

Have an ejection system

Minimum 4 Cans

Automated mechanism

4) Research and Investigation

4.1.2) What is waste reduction?

Waste reduction is the process of minimizing the amount of waste produce in society. Also, helps eliminate harmful waste and make society more sustainable.

4.1.3) What is recycling?

Recycling is the process of making a new products from a product that has originally served its purpose. Recycling prevents useful material resources from being wasted, reduces the consumption of raw materials and reduces energy usage, and hence greenhouse gas emissions, compared to virgin production.

4.1.4) What kinds of materials are recycled in the manufacturing industry?

There are many items made from materials such as aluminum, plastic water bottles, and certain kinds of paper can be separated from your regular trash and put in an appropriate recycling bin such as glass, paper, aluminum, asphalt, iron and textiles.

4.1.5) Explain the operation of several types of waste reduction machines and the applications of each.

The Dominator Crusher breaks up and crushes a variety of materials including bones, chemicals, food, salt and fertilizer. The industrial crusher also delumps virtually all agglomerations and chunks. The Dominator Crusher has six different tooth configurations. This unique feature not only makes our industrial crushers more efficient, but because the teeth can be moved close together or far apart, a greater range of materials can be crushed and different end-product sizes can be achieved.

Features:

- Removable screen drawer assembly
- Single or dual rotor design
- Outboard pillow block bearings
- Multiple rotor tooth designs
- Single or dual driven shafts(s)
- Practical size reduction to 3/16”

- ➢ A variety of drive assembly designs are available including shaft mount, gear head or direct drive

Atritor Cell Mill

The Cell Mill is a highly efficient mechanical mill developed for the production of ultra-fine powders with tightly controlled particle size distributions.
Applications

- Drying
- De-agglomeration
- Fine grinding
- Classifying
- Surface treatment
- Sludges
- Slurries
- Filter cakes
- Granulates

Powders

Balers

Balers are commonly used for a wide range of recyclable materials including paper, corrugated, plastic, cans and containers, tires, and even clothing and textiles. Baling equipment includes:

- Vertical Balers
- Single Ram Horizontal Balers
- Two Ram Balers
- Specialty Balers – for processing clothing, textiles, tires and more
- Custom-built Balers – designed and built for your unique application
- Briquetters and Cubers – for finely textured material

4.1.6) Where and why are compacters used?

Compactors can sometimes be a more practical and cost-effective means for handling and transporting the materials generated in your process. This type of equipment can be a good choice for waste paper, solid waste, product return/product destruction, food waste, and even agricultural waste products. Self-contained compactors offer the flexibility of processing both wet and dry materials, while stationary compactors are typically used for dry materials only. Products include:

- Stationary
- Self-Contained
- Compactor Containers
- Auger
- Pre-crusher
- Specialty Compactors

A compactor is a machine or mechanism used to reduce the size of waste material or soil through compaction. Normally powered by hydraulics, compactors take many shapes and sizes. In landfill sites for example, a large bulldozer with spiked wheels is used to drive over waste deposited by waste collection vehicles.

Different compactors are used in scrap metal processing, the most familiar being the car crusher. Such devices can either be of the "pancake" type, where a scrap automobile is flattened by a huge descending hydraulically-powered plate. The other type is the baling press, where the automobile is compressed from several directions until it resembles a large cube.

These compactors are almost exclusively of welded steel construction for two reasons: durability under pressure and exposure to the elements, as compactors are installed either completely outdoors or sometimes under a covered loading dock.

4.2.1) History of waste reuction in machine design

Throughout history many advancements have been seen in the area of waste reduction and waste management. The Garwood Load Packer is an important part of waste management history because of its revolutionary design. It was the first garbage truck to feature a built in trash compactor. This allowed it to carry more refuse, increasing efficiency in many ways. It was first introduced in 1938 but only entered mass production and use after World War Two. This design paved the way for most modern garbage trucks today.

4.2.2) Recent waste reduction machine developments

An article from the Waste Management World, articulates various methods of waste reduction, specifically anaerobic digestion technology. Although it is not really a machine it is an important step forward in waste management. It works by using microorganisms in an oxygen free environment to break down organic waste. The gases that are released during this process can also be utilized as an effective energy source.

4.2.2) Summarized public article of a recent event concerning waste reduction in manufacturing

An article published by the Unilever Corporation states how they plan to reduce the amount of waste that its factories produce. This includes reforms in the way packaging is done and a reduction in non-hazardous waste sent to a landfill. The factories are on track to have the same waste output in 2020 as in 2008 despite the much higher production. The ways they do this include a reduction production waste and the minimization of packaging. Of the twelve goals outlined in the article two have been achieved, seven are on track to meet their respective deadlines, two are off plan and one has been 99%

achieved. The two that are off track are the goals concerning the reuse of packaging and reduction of sachet waste, both of which have fallen behind schedule because technical and logistical difficulty. The goal that has been 99% completed concerns removing PVC completely from all packaging wherever possible. (Note most of these statistics are unconfirmed by an independent agency and may not be entirely accurate).

4.3) Impacts

As humans we are incapable of entirely not producing any waste, though at this point of time we are producing too much for our planet. Plastics and other waste products are filling up landfills, contaminating the water, polluting the air, creating holes in the ozone and overall releasing horrible things into the place we are trying to live in. Societies are looking for way to reduce the amount of waste and dispose of in the best ways possible. Waste is described as ‘anything harmful to the environment’s sustainability’, waste reduction and recycling is processes that are trying to fix the problems waste originally caused. Fixing is harder than breaking so time, effort and a lot of money is being put into the research of waste recycling and management. Taxes on individuals have been placed to encourage and collect enough money to run the waste management programs and plants. Through the necessity of solutions of waste management jobs have been created and money predicted to be made would be put back into the system. Waste production not only will give a solution for the pollution problem but also could lead to energy security.

4.4) Individual/Organizational Content

Bjarke Ingels has designed an incinerator that doubles as ski slope in Copenhagen, Denmark.

Energy recovery from waste is the conversion of non-recyclable waste materials into useable heat, electricity, or fuel through a variety of processes, including combustion, gasification, pyrolization, anaerobic digestion, and landfill gas (LFG) recovery. The production of this will cost approximately 3.5bn Kroner, or over 525 million US dollars. This will be made up through fees of rentals and general use of the ski hill as well as the profit of the produced energy. The waste-to-energy plant, which will be Copenhagen's tallest building, will replace a 40-year-old incinerator located in an industrial area on the fringes of the city center. More than 50% of waste in Denmark is already used to create energy and the new power plant will be 20% more effective than its predecessor. The building will be wrapped in a green facade created from planters and a lift inside will guide visitors to the top of the "ski mountain" while offering them views of the machinery inside. It is to be opened up in 2016.

4.5.1) Initial Dimensions of a can

A regular sized soda can has a height of approximately 4.8 inches and a diameter of approximately 2.5 inches.

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

The base where the can will be crushed needs to be 6.5 inches long and about 3 inches wide. This way it can crush the can with ease and nothing will be in its way.

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

The long side of the can or the height should be approximately 2.4 inches or less in order to have a 50% or more reduction in volume.

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

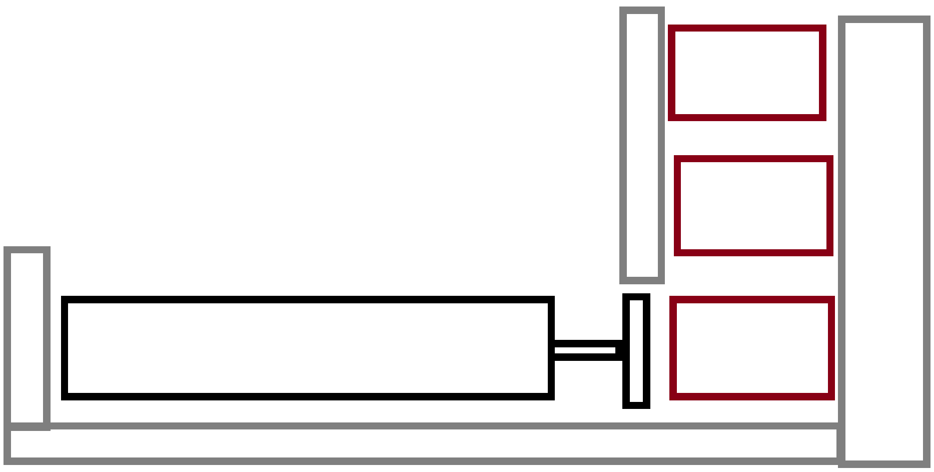
If we are not using a cylinder or any electric source and are physically trying to crush a can, then you can crush a can with any type of force. I’ve searched up how to crush a can just by stomping on it, or even smashing your head against it. But of course, you can’t have a little kid crush it by force, you would need an adult or someone who weighs around 100lb and above.

4.5.6) Would denting the can help crushing it?

Yes, denting a can will help crushing it because you won’t need to apply so much force, compared to a regular soda can with no dents.

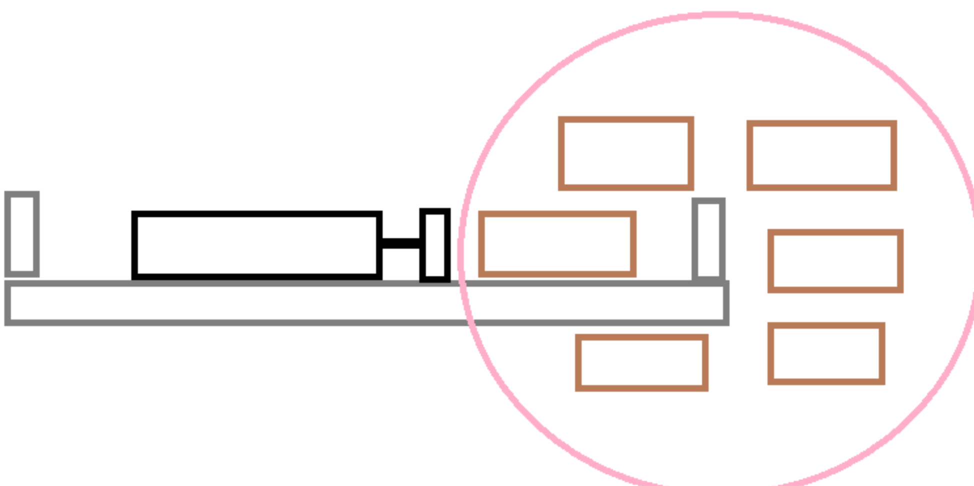
5.0) Create Possible Solutions

5.1) Design #1



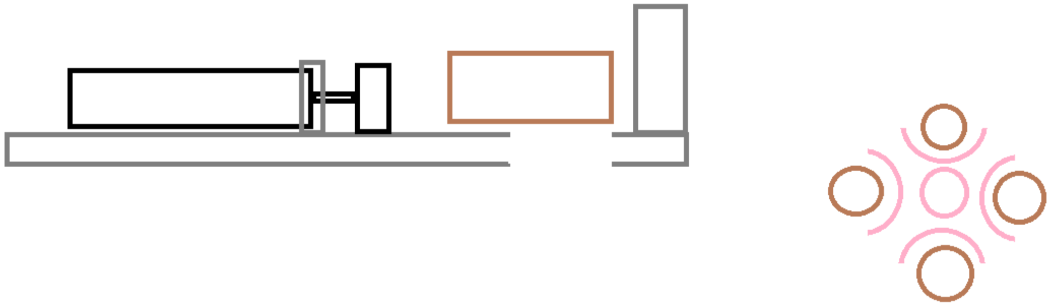
Very simple design where there is a stack of cans and gravity controls the automation.

5.2) Design #2



Very similar to design three but more risky because the motor itself is exposed to the path of the solenoid.

5.3) Design #3



A revolving system where each can is separate from its neighbor and there is only one can in the path of the solenoid at a time. This is achieved by using a microcontroller and motor to spin the rotator then use relays to control airflow and extend/retract cylinder.

6.0) Choosing the best solution

Design #3 was chosen as our final because it was the most likely to succeed. There was a lot less room for error in this design because the cans were isolated and the different mechanical components were isolated.

7.0) Analysis/Development Work

7.1) Calculations with Explanations

Research indicates that a minimum force of 200N is required to crush a can to 50% of it's height.

Let: p = pressure (Kpa)

d_1 = diameter of cylinder

d_2 = diameter of rod

Force:

$$F = 413.7\ kPa\ \pi\ (39.9^2 - 11.2^2)/4$$

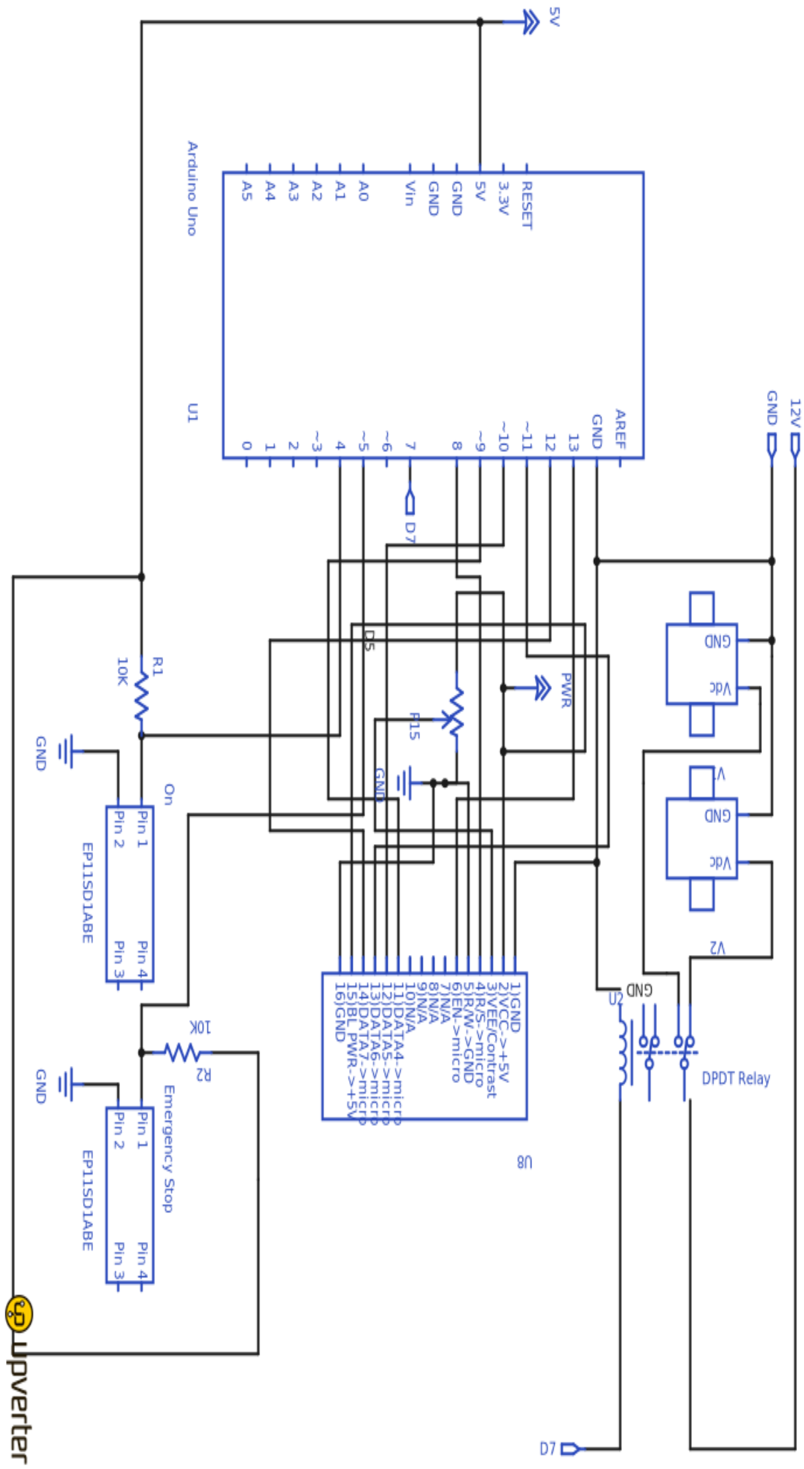
$$\therefore F = 477N$$

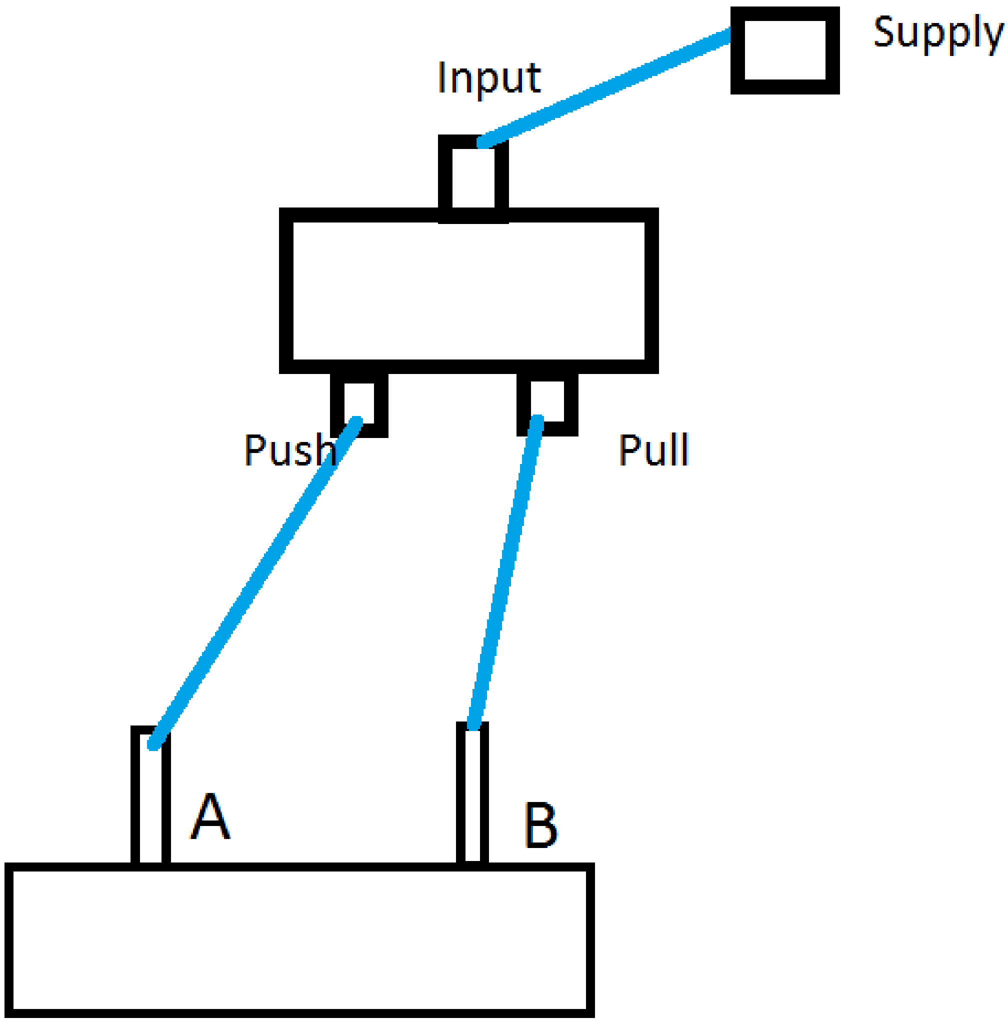
Pressure: $60\ psi = \frac{6.894k}{1\ psi}$

$$= 413.7\ kPa$$

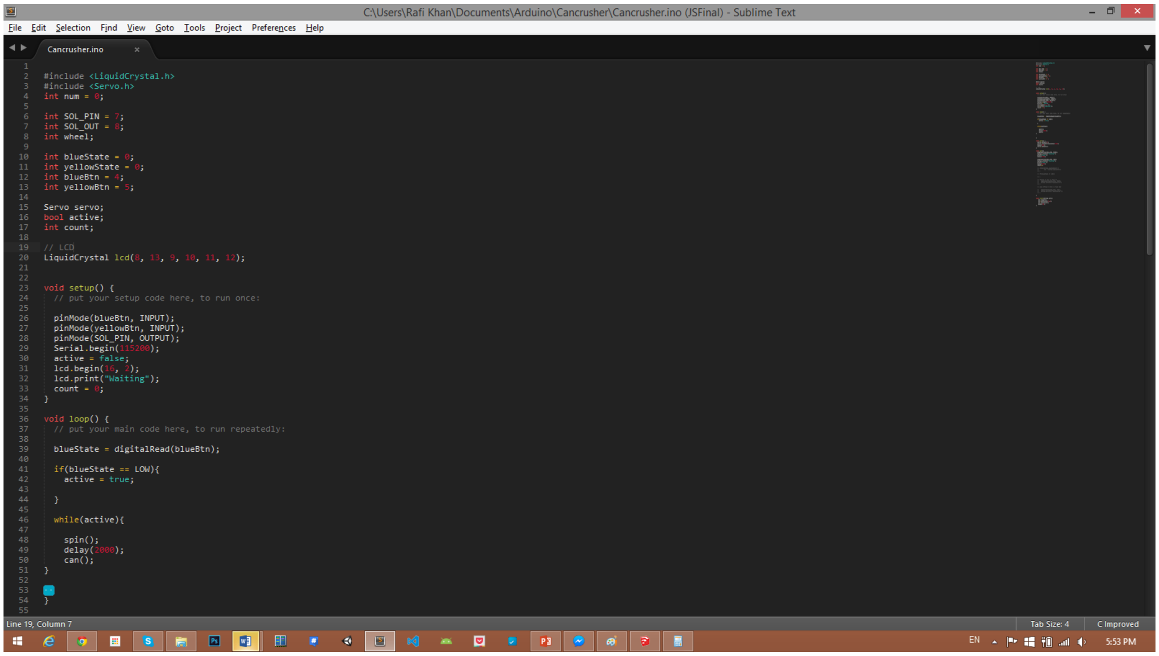
$\therefore$ 477N is enough to crush the can.

7.2) Schematics




Supply
Input
Push
Pull
A
B

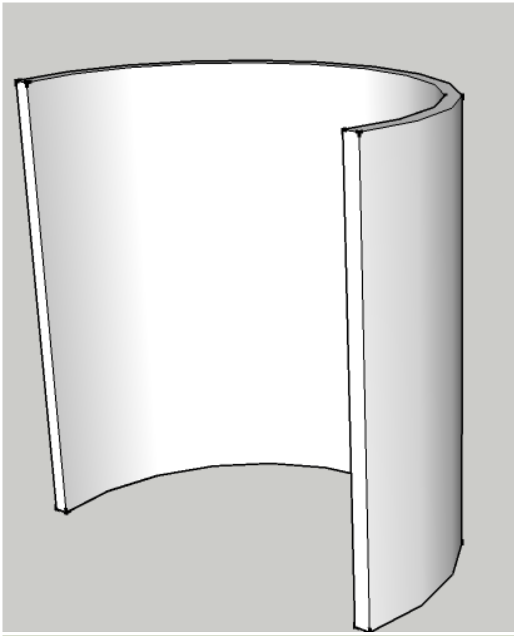
7.3) Programming

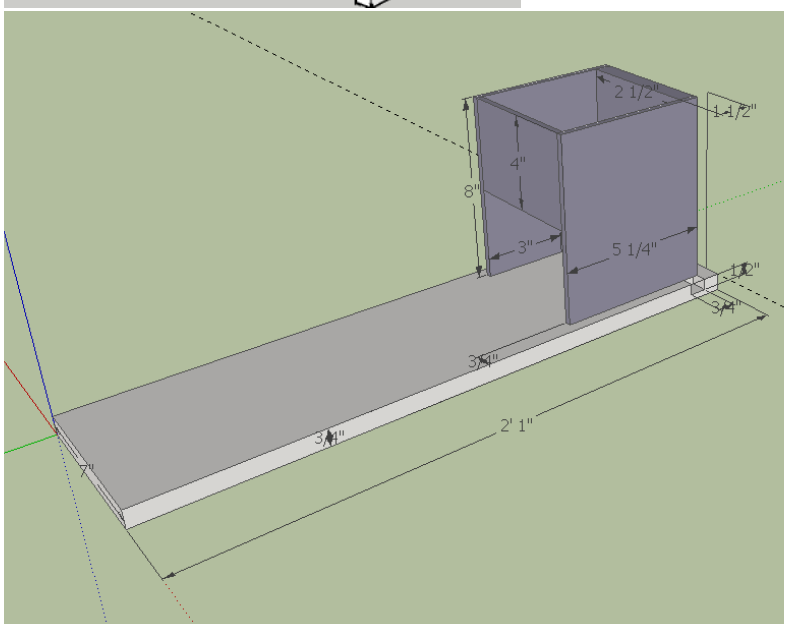


7.4) Bill of materials

Item	Unit(s)	Approx. Cost/Value ($) Per Unit	Total Cost
Pneumatic Cylinder	1	20.00	20.00
Solenoid Valve	2	15.00	30.00
RedBoard	1	13.00	13.00
5V Relay	1	3.00	3.00
LCD Screen	1	5.00	5.00
Assortment of Electronics	1	10.00	10.00
Pneumatic Tubing	3ft.	5.00	5.00
Cost of Construction Materials	N/A	N/A	50.00
Total			136.00

7.5) CAD Drawings

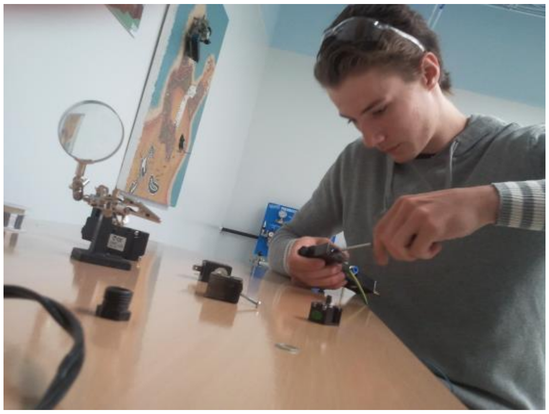


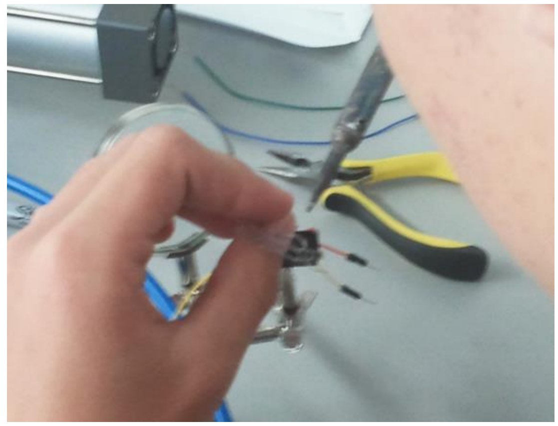


8.0) Construction Process

Building the prototype was one of the last things we did because we wanted to make sure we had everything planned before hand in order to have the smoothest experience possible.

9.0) Testing and Evaluation





9.1) Testing Process

We had a test driven approach to our evaluation because we first determined what it was we wanted to test in a particular test, e.g. cylinder extends and detracts, and then we went in and isolated the components needed ONLY. This way we were able to rapidly develop and test our prototype without leaving any variables out of the question.

9.2) Problems encountered and solutions

The main problems we had were to do with the construction process, although we had no problems in using the tools available, because we knew that there was a very limited amount of time for us to work on building the framework because other elements of the project needed a lot more time. The only notable problem was our first solenoid valve, which we could not get to work, at the end we figured out it was the wrong part, and after replacing it the rest just came together.

Another challenge we faced was figuring out how to control our solenoid valves from the microcontroller, the programming aspect of this was parallel to that of turning on a light but the Arduino and Solenoid valves use different voltages to run their logic. To solve this we used a 5V relay which allowed us to open and close a circuit to control the solenoid valve.

9.3) Areas of Improvement

If we were to repeat this assignment then the only thing we would change is the physical out look of the can crusher, we would make it much more colorful and tidy. Everything else was perfect as our machine had no problems passing our rigorous tests.

9.4) Time Documentation

Week No.	Rafi	Isaiah	Carson
1	Planning	Planning	Planning
2	Electronics Planning	Construction	Construction
3	Construction	Construction	Work on Electronics
4	Powerpoint and Documentation	Documentation	Work on Electronics
5	Finish Documentation and Powerpoint	Finish Documentation	Work on Electronics
6	Testing and Programming	Evaluation	Testing