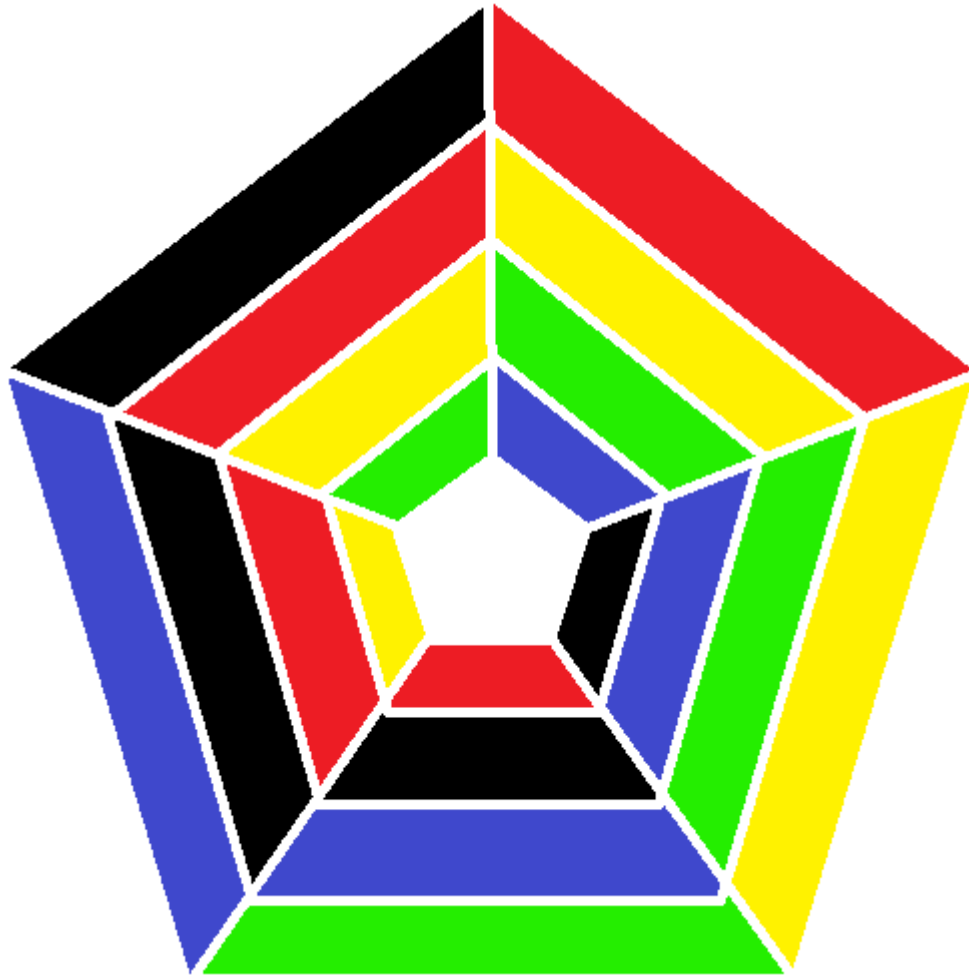


Automated Can Crusher Project

Metal Recycling Solutions



Tyler Lee
Cole Falcon
Brendan Fahey
Brad Freeman
Max Fleming
Kyle Valdes

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Company Titles

President: Tyler Lee

Vice President: Cole Falcon

Chief Marketing Officer: Brendan Fahey

Research Manager: Kyle Valdez

Chief Operations Officer: Brad Freeman

Treasurer: Max Fleming

About Metal Recycling Solutions

Our company is on the frontier for solutions involving aluminum can recycling, with major breakthroughs in space saving technologies. We encourage innovations that involve collaboration between premier robotic systems, advanced pneumatic actuating cylinders, and superior control system programs to instill on the greatest quality and efficiency currently on the market. Our mission is to provide environmentally friendly recycling in a more efficient manner and to employ the use of jubilant minds in creative problem solving. We hope our projects will impact you in a positive way at some point in the not too distant future!

Problem Statement

How could aluminum cans be most efficiently reduced in volume so as to increase productivity in recycling?

Challenge

Design a pneumatic powered device that works in conjunction with a program logic interface involving a robot to accurately transport cans from a cartridge based reloading system to the crushing device which in turn will crush the cans and eject the result.

Design Constraints

- Can Crusher device must be able to fit over the conveyer belt
- Can Crusher device must be able to allow robot claw to release can into crushing chamber
- The Can Crusher must be able to crush the entire can without fail
- Pneumatic actuator must be wired into the program controlled logic interface
- Robot must be programmed so as to repeat a cycle until all cans have been crushed
- Program must allow a delay long enough for solenoid to fully fire

Resource/Materials

- Wood
- PVC Piping
- Plastic Tubing
- Aluminum Solenoid
- Electronic Solenoid Actuator
- Aluminum Wire
- Screws/nuts/bolts
- Tools and Machines in Engineering Lab

Technology Sector Research

By Cole Falcon

Since industrialization took place, waste reduction and recycling have been two critical parts of protecting our environment. Waste reduction is the process of minimizing your waste output, usually by creating a better design or design procedure. Recycling is the process of creating something new from something that has been used. Both waste reduction and recycling are used to maximize efficiency and minimize wasted resources. In the manufacturing industry, many different kinds of materials are recycled. Essentially anything that can still function is reused. This applies to things such as electronic parts, packaging, fiber, cardboard, wood, metal, glass, and textiles. Machines used for waste reduction in industry include grinders, crushers, and shredders. Grinders are used to turn almost anything into dust, while crushers and shredders are used for the size reduction of almost any material. Compactors are used to dramatically reduce the size of large loads of waste, typically used on various types of trash.

Waste management is a more recent problem due to an increase in human population as well as industry. It was common for most waste to be turned to ashes and then released into the ground, but some civilizations had larger waste output than others. The Mayans, for example, has a monthly ritual where they would burn all of their waste in large dumps. After industrialization, the Nuisance Removal and Disease Prevention Act of 1846 was passed, starting the process of regulated waste management in London. Soon after the first incineration

plant was opened in Nottingham to dispose of waste products. The earliest garbage trucks were basic dump trucks pulled by horses. This was the beginning of modern waste disposal.

A more recent example of waste management is shown in Hong Kong, where their 3 primary landfills will be full within the next 5 years. They plan to build a waste to energy facility in order to use the waste in a more effective manner. They also plan to implement odor and pollution control equipment to prevent further harm to the environment as well as Hong Kong's inhabitants.

Recycling has many very positive effects, especially on the economy. Recycling creates jobs, makes for more competitive manufacturing, and significantly improves the U.S. economy. The total annual payroll of jobs connected to recycling adds up to billions of dollars. Recycling also saves money by reducing the costs of waste disposal, such as landfills and incinerators. Not only has recycling had an impact on the economy, but it has also had an impact on the environment. Recycling significantly reduces pollution levels and carbon emissions. The overall goal of recycling and waste reduction is to preserve natural resources, prevent the expansion of landfills, and prevent further pollution.

One organization that has had a significant impact on the recycling field is Ceres. Founded on March 24, 1989, Ceres was one of the main organizations trying to publicize the risk of poor waste management, revealing just how significantly recycling can affect all aspects of our life. They are located in Boston, Massachusetts. Ceres's goal is to show the world that recycling is critically important to us and our environment. One of the primary defeats faced by Ceres is the United States' rejection of the international Climate Change Treaty in 2001. Although it was a large setback, the organization eventually recovered and began gaining

ground. Ceres is a non-profit organization. Over the 25 years that Ceres has been established, they have made important contributions to the recycling industry, especially making sustainability reporting common practice. Currently, 93% of the world's top 250 companies now report their common practices.

Over time, recycling and waste reduction has had a significant positive impact on society, industry, and the environment. With increasing global population and industry, recycling has become a critical part of a clean planet. Thanks to clever operations and applications, a rich history of the development of recycling technology, various impacts on the human race, and organizations such as Ceres, recycling will likely keep our planet clean for years to come.

Bill of Materials

Store: Home Depot

#	Item Name	Description	Thickness	Width	Length	Qty.	Price	Model Number
1	Plywood	Untreated Plywood	7/16"	4'	4'	1	\$7.16	386081
2	PVC Pipe	PVC Pipe	3"	3"	3'	1		
3	Stud	Wooden Plank	1 1/2"	3 1/2"	8'	1	\$3.05	161640
4	Screws	Coarse Original	1"			75		

Inventory List

Number	Name	Description	Length	Width	Height	Quantity
1	Deltrol Controls	Resistor	1 1/4"	1 1/2"	2"	2
2	Tyco Circuit Boards	Electrical Control Center	3"	1 1/2"	1"	2
3	Large Solenoid	Can Smashing Solenoid	11 1/2"	1 3/4"		1
4	Air Tubing	Pipe for Air Flow	20'	1/4"		1
5	Black Wire	Electrical Wire	20'	1/16"		1
6	Blue Wire	Electrical Wire	20'	1/16"		1
7	PTFE Thread Seal Tape	Metal Pipe Joint Sealing Tape	43 1/3"	1/2"		1
8	Small Solenoid	Can Removing Solenoid	5"	7/16"		1
9	Mounting Bracket	90° Metal Fitting to Hold Small Solenoid to Wood	1 5/8"	1"	1 3/8"	1
10	Mounting Bracket	90° Metal Fittings to Hold Large Solenoid to Wood	2 1/2"	1 1/2"	1 7/8"	2
11	Air Control Fitting	Metal Block with Air Flowing through and Out at 90° Angle	5/16"	5/16"	3/4"	1
12	Rubber O-Rings	Rubber Rings to Seal Air Valves	1/4"			10
13	Air Output Fitting	Metal Fitting which Changes Air Output to Metal Pipe Fitting	1 5/8"	1/2"		1
14	Metal Washers	Metal Circles for Spacing	13/16"			2
15	Metal Pipe Fitting	Female to Female Metal Pipe Fitting for Air Flow	13/16"	1/2"		1
16	Air Nozzles	Air Flow Nozzles to Connect Pipes	1"	1/8"		12
17	Air Input Fitting	Metal Fitting which Changes Air Input to Metal Pipe Fitting	1 1/4"	3/8"		3
18	Air Input Fitting	Metal Fitting which Changes Air Input to Metal Pipe Fitting	1"			9
19	On Switch	Green Push On Switch	1 1/8"	1 1/8"	1 1/4"	1
20	Control Switch	Circuit Control Switch (1 and 2)	1 1/8"	3/8"	15/16"	1

21	Off Switch	Red Push Emergency Off Switch	1 1/2"	1 1/2"	2"	1
22	Control Switch	Circuit Control Switch (3 and 4)	1 1/8"	3/8"	15/16"	1
23	Directional Valve	Solenoid Directional Control Valve	7/8"	5/8"	2 1/4"	2
24	Mounting Bracket	Metal Piece to Join Solenoid Directional Control Valve to Wood	1 5/8"	1/2"	1/8"	2
25	Limit Switch	On/Off Switch Changed When Hit	1/2"	1"	1/2"	5
26	Safety Cover	Plastic Electrical Shielding for Electrical Components	2"	3/4"	5/8"	5
27	Time Delay	Delay Switch	2"	2"	2 1/4"	1

Invention and Design Report

Step 1 (Problem Statement): How could aluminum cans be most efficiently reduced in volume so as to increase productivity in recycling?

Step 2 (Description of Research Collected): The majority of the research we found was based on creating the prototype itself as such pneumatic devices only seem to exist on an industrial scale and thus we were left to imaginations for creating our personal can crushing device. Thus, our research came largely from Google images as a small source for inspirational ideas to include, as well as from Ceres, a company that has shown promise in the field of recycling innovations and seems to be able to have an impact in the environmental industry.

Step 3 (Possible Solutions): (See Appendices) Our first attempt at creating a prototype involved a streamlined design which inevitably was inefficient. (Sketch A) The robot's inability to reach portions of the crusher was what made us scrap the project along with no involvement of the robot claw. The second sketch (Sketch B) developed set the precedent for the final product as it was the first to involve placing the can crusher over the conveyer belt so as to eject the final crushed can onto the conveyer belt. Unfortunately the reason this design was not chosen is because of the over complexity involving pressurizing the solenoids as well as inexact exit of the can onto the conveyer belt was not precise enough to ensure this would work every time. The final sketch created (Sketch C) is essentially the final product minus a few modifications made during the construction process. The overarching idea was to take the ideas from Sketch B and simplify them to create errorless device.

Step 4 (Final Design): The final design was decided upon largely due to its small structure and involvement of the conveyer belt as the ejector system as shown in the photos. It also held the advantage of being perpendicular to the robot so as to allow simple programming regarding the vertices and lowering of the can into the crushing chamber. The final design works by lifting the cans from a cartridge based loader and moving them to a PVC pipe chamber blocked on one side with wood and the other by the head of the solenoid. In turn the program sends a signal to the pneumatic actuator to fire the solenoid which crushes the can against the wood. After the solenoid retracts, the can is then free to fall through a hole in the bottom of the structure onto the conveyer belt, ready for further extraction. (See Appendices)

Step 5 (Development Work): (See Appendices) The schematic shown on page 28 is the simple circuit involving the power source located on the program control unit, the electronic actuator controlling the flow of air to the solenoid, and lastly the program control unit which is linked to the computer. This circuit works by providing power to the actuator to reverse the flow of air while being controlled by the computer. The inventor drawing (shown on page 29) is the final

product constructed using Inventor 2010 and is correctly dimensioned. This 3-D object was then used to provide the insight in manufacturing the final device. The program we used is also copied in the appendix on page 27 and simply shows the steps the robot takes in grasping the can, relocating it, dropping it into the can crusher, and then the can crusher crushing it.

Step 6 (Construction Description): The materials for this project were obtained via a kit derived by Amatrol as the essential ingredients for such a project, as well as from materials originating in the lab obtained from previous projects and orders from Home Depot. With these materials the wooden framework was created with power tools such as a portable drill and band saw which the solenoid and PVC pipe were then fitted to. When the time came to create the head to be mounted on the solenoid for physically crushing the cans the initial impression was such a part was to be designed on Autodesk Inventor and then printed on the Makerbot 3-D printer. Instead, the finished head was cut out of wood and installed with additional hot glue to the solenoid which was the only major change to the project.

Step 7 (Testing and Evaluation): Testing the robot included a vast amount of time programming the robot to respond to commands and to consistently follow the same steps in relocating the cans to the pneumatic powered crushing device. From here, the program was run hundreds of times to ensure a quality sequence was performed despite any issues surrounding the cans being slightly deformed in the process of gripping them with the robotic claw mechanism. One slight flaw was found to exist in the wooden framework as a stud was not perfectly placed and thus required additional use of a sawzall to remove the excess material preventing the cans from dropping onto the conveyer belt. The results of testing allowed us to remove the remaining errors and create a program which is both functional and efficient for an overall near perfect machine. The only remaining area for improvement with such a device would be downscaling it to fit large-scale manufacturing requirements, but as a prototype it fulfills its role to the initial desire.

Self-Evaluation

By Tyler Lee

As president of Metal Recycling Solutions, I found I had to deplore my experience in many fields of engineering yet the most important aspect to completing the project was my leadership role. By analyzing the skill sets of each individual, I delegated the tasks required to accomplish our goal before the deadline so as to create a model of efficiency and dependability for each member of my group. Tasks specific to me included construction of the physical can crusher, wiring of the electrical components, creation of the design brief, overseeing company attributes, programming the robot, and designing the PowerPoint presentation. In these regards I believe that I was successful and enabled my group to accomplish the task at hand to the best of my abilities.

Self-Evaluation

By Max Fleming

As treasurer of our company, Metal Recycling Solutions, it was crucial that I monitored the company budget, making sure that we could obtain all the necessary materials and do it for less than 300\$. Throughout the process of building the can crusher, I often assisted in the construction of several parts needed for the completed product, such as the pneumatic can crusher. This process required me to shape, and sand down a piece of wood that fit our original design. When the construction process was finished, I worked with the company president, Tyler, to wire the pneumatic cylinder, allowing it to move and crush the cans. As well as helping in the construction process, I thought of ideas for a company logo, and helped graphically design the logo. My group members also decided that I exemplified textbook drilling procedures.

Self-Evaluation

By Cole Falcon

As vice president of Metal Recycling Solutions, I would say that I played a crucial part in the progress of our project. I played a hand in the designing of the company's logo, and worked together with Tyler to create our company name. In addition to this, I created the rough draft for the Technology Sector Report. I also created a rough draft for our Design Brief. Although I mainly created the written portions of the project, I also assisted in the construction of the Can Crusher. This was mainly done by sanding pieces of the crusher that were nearing completion. I also did my best to keep the members of the group on task and motivated. Overall, I feel that my contributions to the group significantly helped in completing the project on time.

Self-Evaluation

By Kyle Valdez

As Research Manager I was responsible for the assistance (along with the rest of my group) to come up with a build materials list for our can crusher. Also I aided our president Tyler in the building of the main structure of the crusher along with the programming of the pneumatics system. Along with the programming I also contributed to the aid of the can crusher as a whole in the construction process and post construction testing. I helped find several flaws and correct these issues in the prototype.

Self-Evaluation

By Brendan Fahey

As General Marketing Director of (I honestly forgot our company name) I had the role of getting our company name out there. I designed the logo along with my fellow co-workers.

The robot programming process was carried out by Bradford Freeman and myself. I helped the construction by sanding, cutting, and applying necessary parts for the success of the “can crusher.” I also contributed cans for the testing process of our product.

Self-Evaluation

By Brad Freeman

My contribution to the project was largely in assistance with minor research details for cost analysis and secondary initial programmer of the robot. This project enabled me to envision the powerful results of a career in engineering and the possibilities that are invoked by such a broad spectrum of subject areas associated with the field in general. Developing the initial program entailed my knowledge of robotic programming gained from completing the Amatrol lab and while this program was scrapped it did provide the foundation for the final project. Overall, while engineering may not be my pathway, I did gain valuable insight from working on this task and look forward to similar future engagements.

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