TRC2001 Year 2024 Semester 2
‘Automated Can Crusher’ Project Report

Prepared by

Group 14 - ‘The Special Group’

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Abstract

This project focuses on designing an automated aluminium can crushing system aimed at enhancing waste reduction and recycling efficiency. The primary design objectives include automation, efficiency, safety, durability, and user-friendliness. The system is powered by a pneumatic cylinder, which generates sufficient force to crush cans to a fraction of their original size. It operates automatically once powered on, detecting cans and initiating the crushing process without user intervention. Key safety features include a kill-switch to prevent accidental operation when hands are near dangerous areas. The system integrates inductive sensors for can detection, a conveyor belt for transportation, and a programmable logic controller (PLC) to manage the logic and sequence of operations. Built from durable materials, the system is designed to be energy-efficient and robust, ensuring long-term use in both household and commercial environments while promoting environmental sustainability through streamlined waste management.

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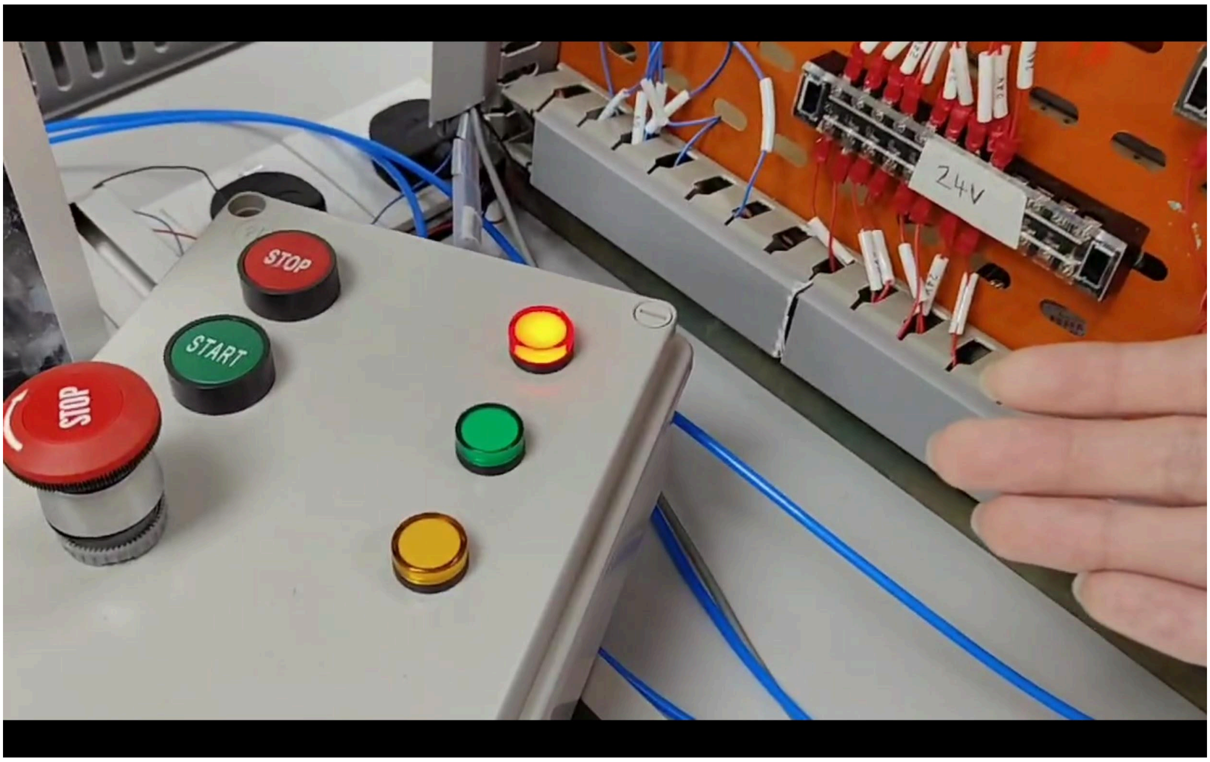

Figure 1: Control Panel

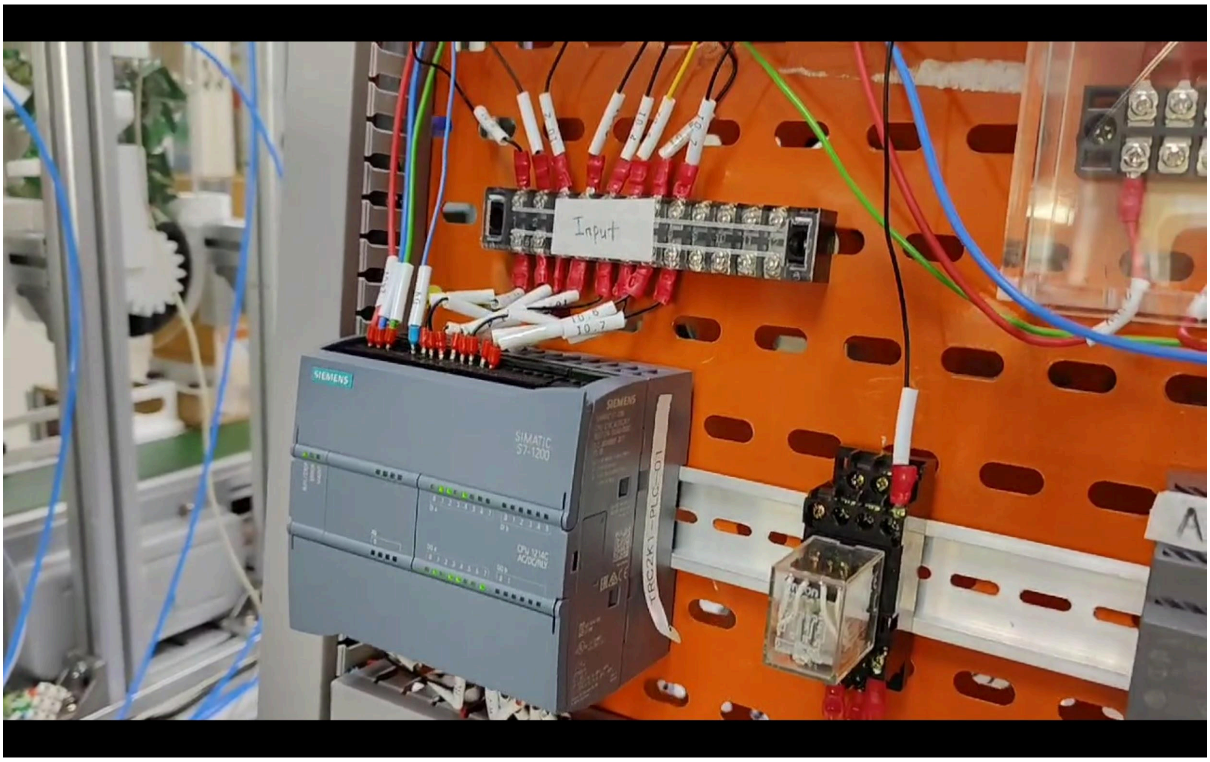

Figure 2: Programmable Logic Controller (PLC)

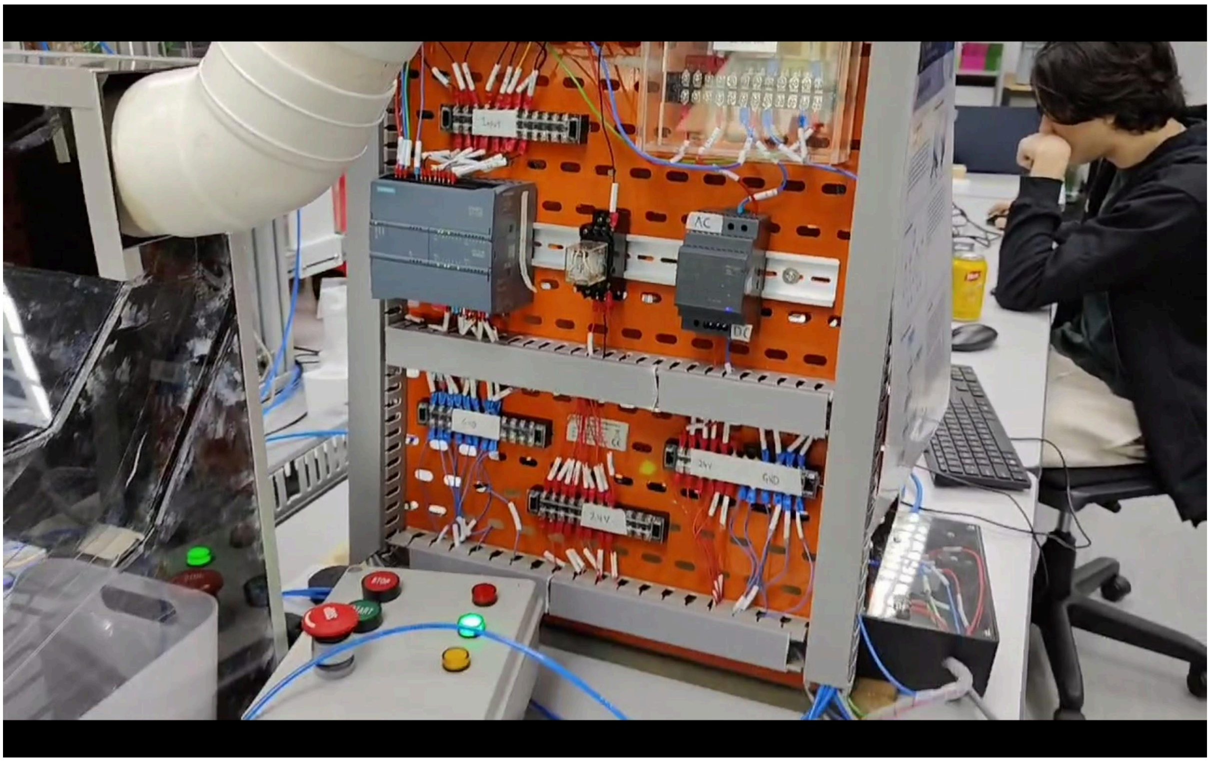

Figure 3: Wiring of the System

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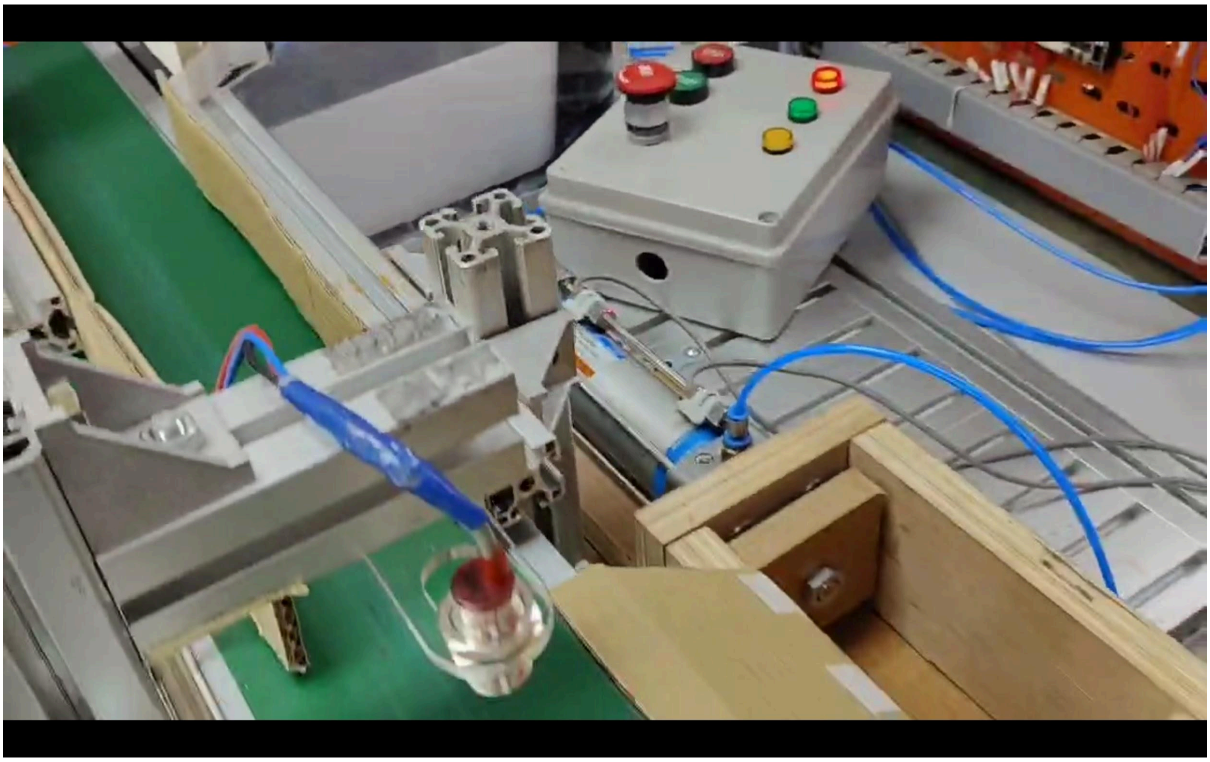

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Figure 7: Real Life Front View

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1.0 Introduction

1.1 Problem Definition

The increasing consumption of aluminium products has led to a significant rise in waste, particularly in the form of used aluminium cans. Improper disposal of these cans contributes to environmental pollution and the inefficient use of recyclable materials. Manually crushing and sorting cans for recycling is labour-intensive, time-consuming, and prone to human error, making it less viable in both household and commercial settings.

There is a need for an automated solution that can efficiently crush and sort aluminium cans, reducing their volume for easier transportation and recycling. The system must be user-friendly, energy-efficient, and capable of operating with minimal supervision while maintaining safety standards to prevent accidents during operation. Additionally, the system must be durable to withstand continuous use in environments where large amounts of cans are processed, such as recycling facilities or commercial establishments.

The challenge is to design a robust and sustainable automated can crusher that not only reduces the effort and time required for recycling but also contributes to environmental conservation by streamlining the waste management process.

1.2 System Overview

The Automated Can Crusher system is designed to efficiently compress aluminium cans for recycling, reducing the manual effort required in waste management and contributing to environmental sustainability. The system consists of several key subsystems working in coordination to automate the process from the collection of cans to their crushing and final storage.

1. **Funnelling Subsystem:** This subsystem directs aluminium cans and other materials onto the conveyor belt for processing. It sorts objects based on weight, separating out heavier, unwanted items from lighter cans. The funnelling system ensures that only the appropriate materials are passed onto the next stage.

2. **Conveyor Subsystem:** The conveyor belt transports cans through the system. It is activated when the system is powered on and stops automatically based on input from the Can Sensing and Emergency Stop subsystems. A control panel allows users to manually start or stop the conveyor, with indicator lights showing the system's operational status (green for running, red for stopped, yellow for emergency stop).

3. **Can Sensing Subsystem:** Using an inductive sensor, this subsystem detects the presence of aluminium cans as they move along the conveyor. When a can is detected, the sensor sends a signal to the Programmable Logic Controller (PLC), which halts the conveyor to allow the next step of the process. Non-aluminium objects are ignored, allowing the system to focus on recyclable cans.

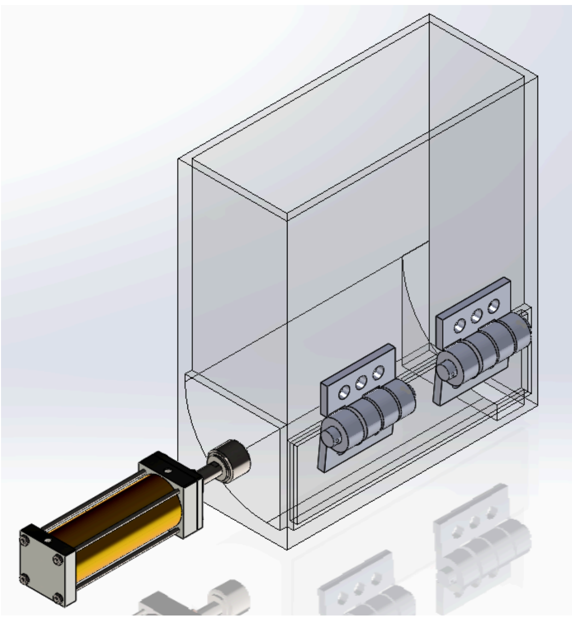
4. **Pushing Cylinder Subsystem:** Upon detection of an aluminium can, this subsystem activates a pneumatic cylinder that pushes the can from the conveyor into the Crusher Subsystem. This process is controlled by the PLC to ensure precise timing and alignment.

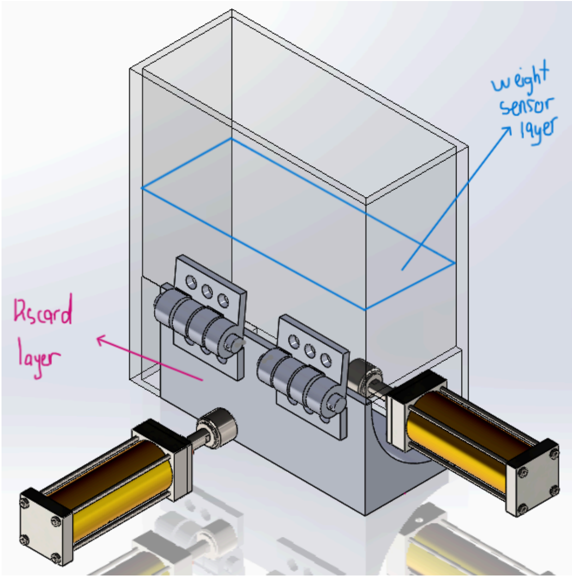
5. **Crusher Subsystem:** The core of the system, the Crusher Subsystem, is powered by a pneumatic cylinder that crushes the aluminium can within a wooden box structure. Magnetic sensors detect when a can is correctly positioned in the box, triggering the crushing operation. The crushed can is then dropped into the Collection Box Subsystem.

6. **Collection Box Subsystem:** This subsystem collects both the crushed aluminium cans and any heavier materials that were sorted out earlier in the process. The box is designed to store the processed materials until they can be removed for recycling.

7. **Safety Subsystem:** Integrated throughout the system is a safety mechanism, which includes an emergency kill switch. When the kill switch is pressed, the entire system is immediately halted and returned to i to prevent accidents, and a yellow light indicates the emergency state.

1.3 Alternative Designs

Design 1:  Figure 9: Alternative Design 1	In this system, a can is dropped into the mechanism through a conveyor belt. If the can is filled, compressing it could be dangerous. The design ensures that a filled can, due to its weight, will naturally open the door, preventing it from being compressed. Conversely, if the can is empty, it will not have enough weight to open the door and will therefore be safely compressed. The system also incorporates an ultrasonic sensor to control the speed at which cans are dispensed into the system. Additionally, a metal sensor is included to detect whether the object is metal or not.

Design 2:  Figure 10: Alternative Design 2	The cans or other objects will enter the design through a conveyor belt. Design consists of 2 layers, a weight sensing layer and a compression/discarding layer. Both layers are held closed by a retractable working cylinder where the platforms are attached to the walls of the design by a hinge. Layer 1 consists of a weight sensor, once the object has had its weight measured, the first cylinder retracts, platform opens and the object drops to the second layer. In the second layer is a metal induction sensor where it detects whether the object is metal or not, if it is not metal or the object is too heavy, then cylinder 2 retracts, platform opens and the object is discarded. If it is metal a compressing cylinder from the front will extend and compress the can.

1.4 Proposed Solution

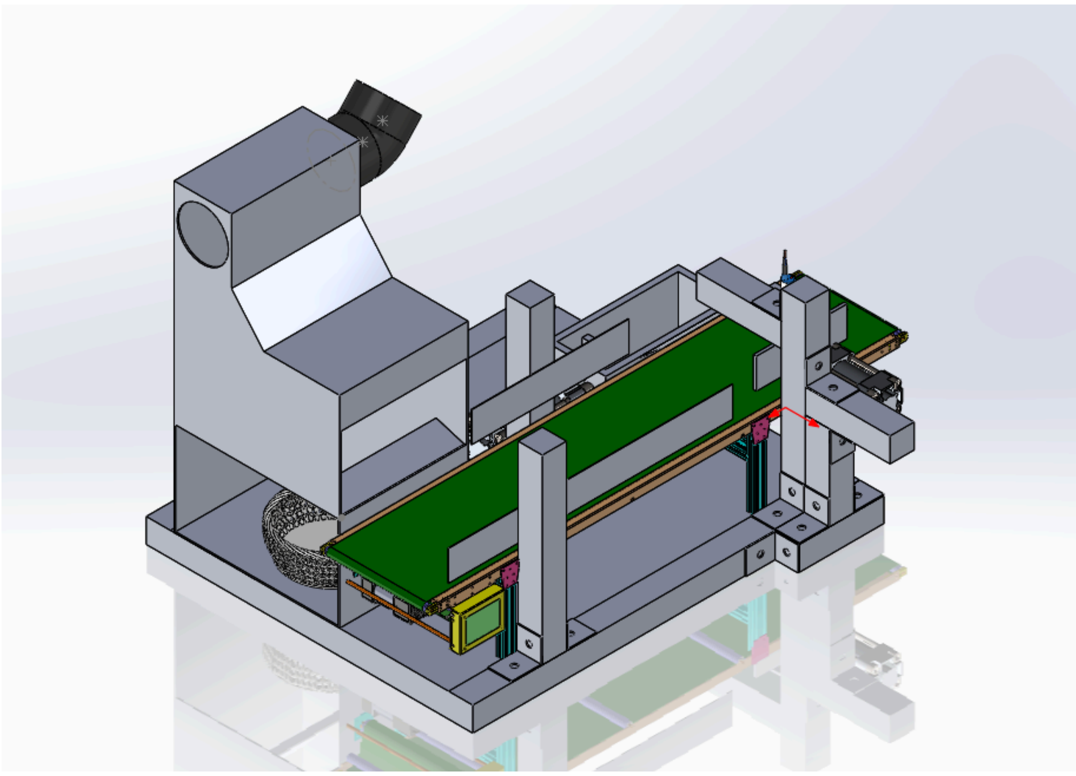


Figure 11: Front View of Design

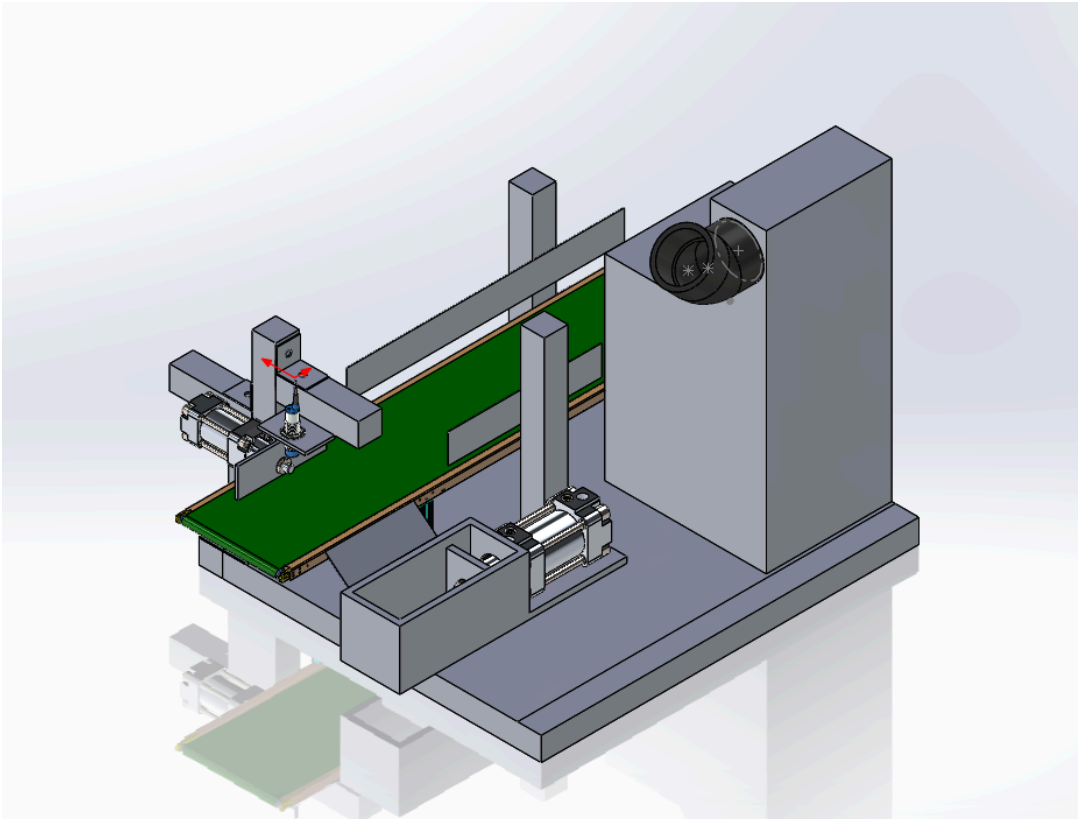


Figure 12: Back View of Design

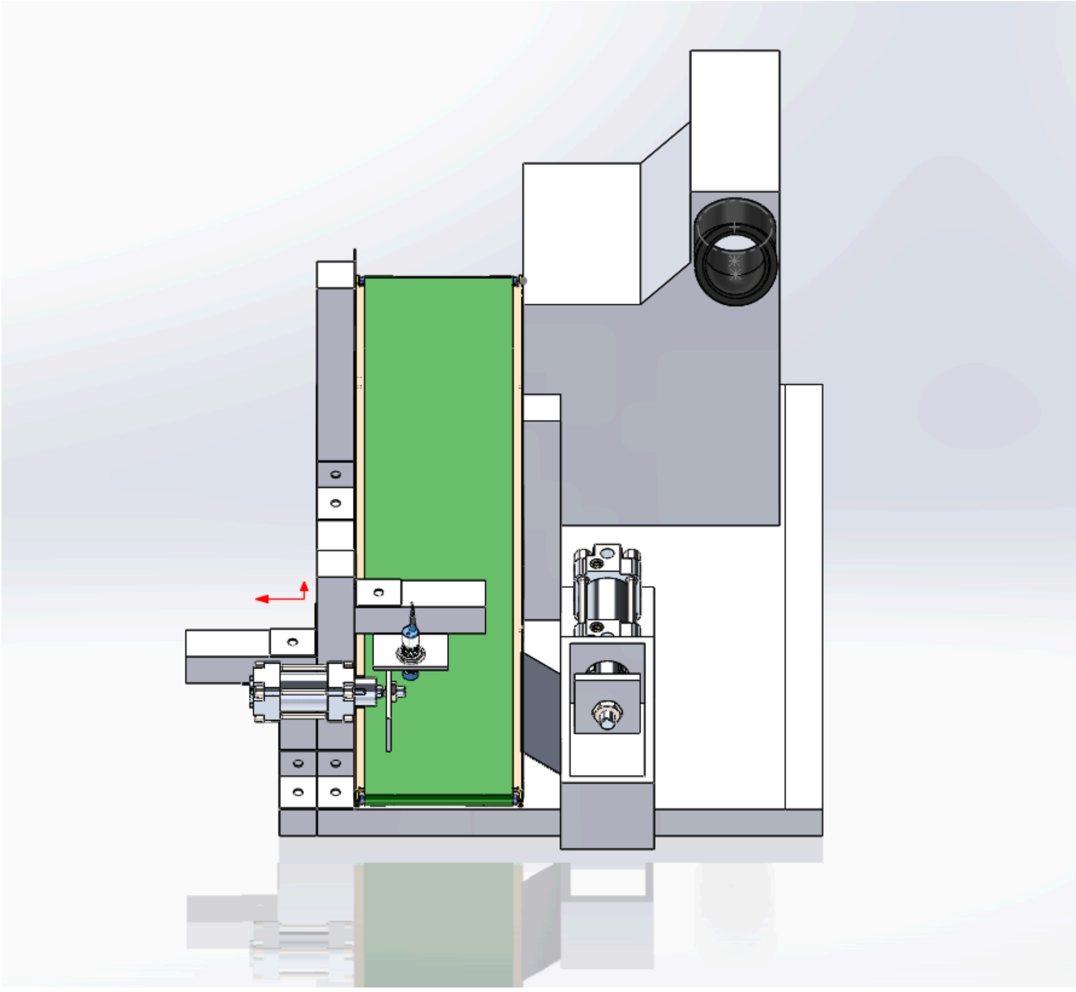


Figure 13: Top View of Design

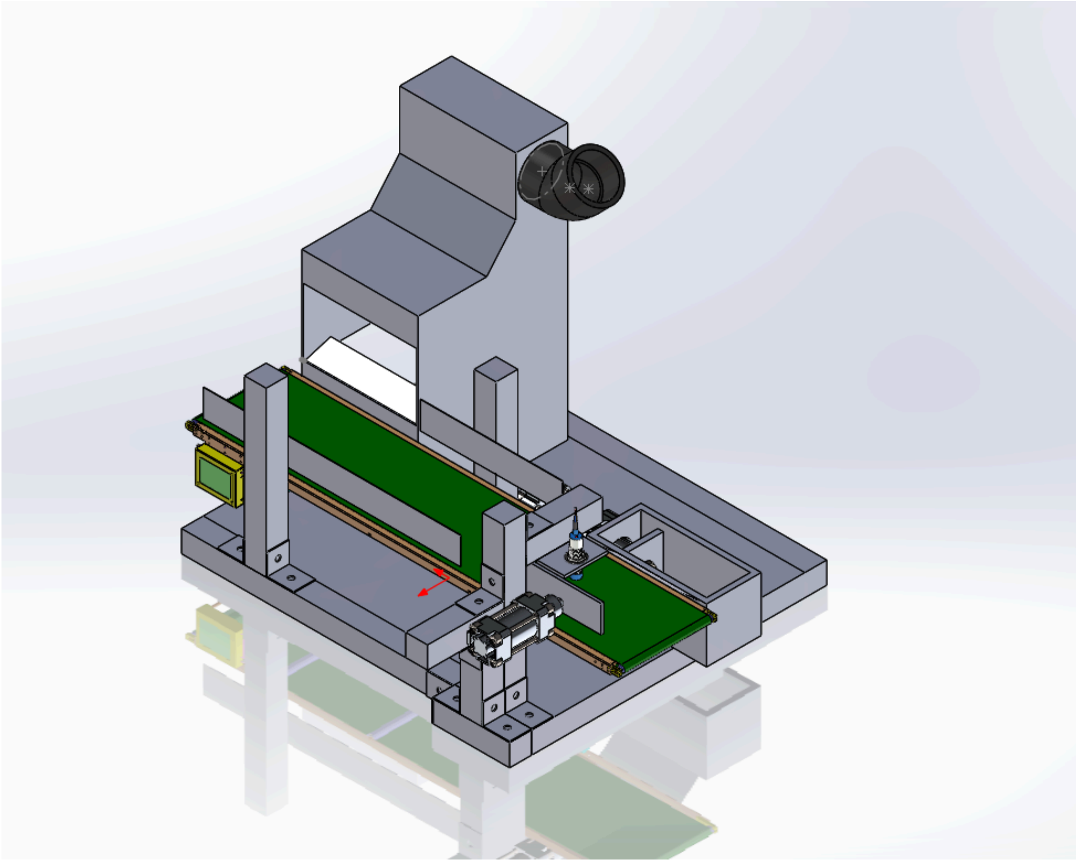


Figure 14: Side View of Design

In the proposed solution, the design separates the sensing, sorting, and crushing mechanisms to streamline the process while simplifying the overall system architecture compared to alternative designs. This approach minimises the complexity of integrated operations, though it results in a slightly bulkier structure due to the physical separation of components. Despite this, the design offers significant advantages in terms of ease of manufacturing, system maintenance, and troubleshooting.

1.4.1 Operation Flow

1. Item Input via Pipe: The process begins when an aluminium can or plastic bottle is dropped into a pipe, which serves as the entry point for items.

2. Weight-Based Sorting Mechanism: Once inside the pipe, a simple gravity-based sorting system comes into play. If the item is heavier than a typical empty can (e.g., a filled can, a non-crushable object, or a heavy bottle), it falls through a layer of broom hairs into a hole at the bottom of the pipe into a basket. This mechanism takes advantage of the natural weight difference between empty aluminium cans and heavier objects. By utilising this basic principle, the design eliminates the need for complex electronic weight sensors, reducing system complexity and potential maintenance issues. It also makes it very coefficient by taking everyday appliances and transforming them into part of a complex mechanism.

3. Conveyor Belt Transportation: If the item is light enough (e.g., an empty aluminium can or plastic bottle), it will bypass the hole and be directed onto a conveyor belt. The conveyor belt serves as the transportation mechanism that moves items from the sorting subsystem to the sensing and crushing subsystems. It operates automatically, moving items toward the sensor in a controlled and orderly manner.

4. Sensing Subsystem: Once an item reaches the sensor, the system uses an inductive sensor to detect its material. Inductive sensors are well-suited for this task because they can identify metallic objects, such as aluminium cans, without physical contact. If the object on the conveyor is a plastic bottle, the sensor will not detect any metal, and the system will allow the plastic bottle to continue moving along the conveyor until it reaches a bin at the end. This prevents unnecessary interaction with the crushing subsystem, ensuring that only the intended materials are processed.

5. Metal Can Detection and Pushing Mechanism: When the inductive sensor detects a metal can, it sends a signal to the Pushing Cylinder Subsystem, which activates the pneumatic cylinder. This cylinder extends, pushing the can off the conveyor and into the Crushing Subsystem. The decision to physically separate the sensing and pushing operations, as opposed to integrating them, allows for greater precision and reduces the likelihood of malfunction due to misalignment or sensor error.

6. Crushing Subsystem: Once the can is pushed into the crushing area, a pneumatic cylinder exerts high pressure to compress the can inside a designated box. This crushing operation significantly reduces the volume of the can, making it easier to store and transport for recycling. To ensure the process is smooth, a magnetic sensor within the crushing box confirms the can's position before crushing begins. This minimises the risk of mechanical jamming or system wear due to misaligned cans.

7. Post-Crushing and Automatic Discharge: After the can is crushed, the cylinder retracts, and the compressed can automatically drops through a hole at the bottom of the crushing box. This design feature ensures the continuous flow of operations without requiring manual intervention for can removal, allowing the system to handle multiple cans in sequence efficiently.

8. Plastic Bottle Handling: As a fallback, any plastic bottles detected by the sensing subsystem are not pushed into the crushing box but instead continue moving down the conveyor to a separate bin. This maintains a clean separation between recyclables, ensuring that only aluminium cans are crushed, while plastic bottles are directed to a different collection area.

1.4.2 Advantages of the Separated Mechanisms

By separating the sensing, sorting, and crushing mechanisms, the design offers several operational advantages:

Simplicity in Manufacturing: With clearly defined and modular components for each function (sensing, sorting, and crushing), manufacturing becomes more straightforward. Each subsystem can be built, tested, and maintained independently, which simplifies the production process and reduces assembly time. The separation allows for easier troubleshooting, as issues in one subsystem (e.g., the conveyor belt or the pneumatic crusher) can be isolated and resolved without affecting the others. This modularity also supports future upgrades to individual components.

Efficiency in Material Handling: The design ensures efficient sorting and processing of aluminium cans and plastic bottles, preventing the unnecessary crushing of non-metal items. This extends the system's lifespan by reducing wear and tear on the pneumatic crusher.

Energy and Cost Efficiency: The system’s energy consumption is optimised by only activating the pneumatic cylinder when a metal can is detected, avoiding unnecessary power usage for non-metallic items. Additionally, separating the functions minimises the potential for complex, integrated electronics, lowering both initial costs and long-term operational expenses.

1.4.3 Trade-offs

While the design simplifies the sensing, sorting, and crushing processes, the trade-off is a slightly bulkier structure due to the physical separation of the subsystems. The system's footprint is larger compared to more compact, integrated alternatives, but this trade-off is considered acceptable given the benefits of simplicity, modularity, and ease of manufacturing. The added bulk is offset by the enhanced durability and reliability of each subsystem working independently.

In summary, this proposed solution provides a highly efficient and user-friendly system for sorting and crushing aluminium cans, with minimal complexity in both operation and manufacturing. It is robust, adaptable, and designed to handle a high volume of recyclables in an energy-efficient manner.

2.0 System Design and Development

2.1 Design Objectives, Requirements, Components Selection

The primary design objective of this project is to design an automated system that can efficiently crush waste aluminium cans with minimal effort which will then be stored and recycled. Beyond functionality, the design also aims to be environmentally sustainable by streamlining the waste reduction process. Most importantly, the system should be user-friendly and capable of operating with minimal supervision.

The main requirements of the system focus on several key aspects, which includes automation, efficiency, safety, durability, and conveniency. First of all, the system must be able to generate sufficient amounts of force through a pneumatic system to successfully compress cans to a fraction of their original size. The system should also automatically initiate once powered on, which means whenever aluminium cans are detected, the crushing process should undergo without any user intervention, and continuously repeated until powered down. To ensure safety, a kill-switch should be implemented to prevent the crusher from operating when human hands are exposed to the dangerous areas. The system should also be energy-efficient to reduce power consumption, especially in household or commercial settings. Finally, the structure of the system must be built using durable materials to withstand repetitive stress from the crushing operations onto the components.

The key factors that drive the selection of the components are related to the requirements. The primary component responsible for the crushing operation is the pneumatic cylinder, chosen for its ability to generate high amounts of force using compressed air. Pneumatic cylinders are also more energy-efficient and flexible than hydraulic cylinders. Also, inductive sensors are incorporated into the system to detect the presence of aluminium cans, triggering the automation sequence. A conveyor belt is also used to transport cans for sorting and crushing operations. The most important component would be the programmable logic controller (PLC), which acts as the brains of the system, managing the inputs and outputs to control the entire system's logic and sequence. A control panel must also be included to allow the user to freely power the system on and off, controlling its operational state.

2.2 Mechanical, Electrical, Electronics, Mechatronics Aspects

The mechanical aspects of the system prioritises the overall design, functionality of the crushing operation, and obtaining structural integrity. To prevent system failure, the materials used to construct the crushing box are high quality wood that are thicker than average. This allows the box to support the repetitive force generated during operation and withstand wear and tear of continuous use. Not only that, in order to fix the system on a base, L-shaped corner brackets and aluminium extruded cuts were used to secure the system to a base properly, while nuts and bolts were used to tighten the components together. Most importantly, cardboards were employed to act as a guide rail to ensure smooth transport of the aluminium cans to their destination so that the cans will be properly aligned before being crushed. Besides that, in order to achieve the weight sorting subsystem, a filter box made out of acrylic was constructed, which also implemented bristle that prevents empty cans from falling through while allowing filled cans to fall through due to gravity. Thus, successfully separating empty cans from filled ones.

The electrical aspect of the system revolves around powering and controlling the system's various components to achieve its function. A crucial part of the electrical system is the control panel, which oversees the device's power. Start and stop buttons, as well as a kill switch are incorporated into the control panel to provide more flexibility to the users in terms of controlling the operational state of the system. Due to the need of DC current to power the system, an AC/DC converter is also essential to properly provide the correct power to the system. Most importantly, the electrical wiring between each component must be firm and robust as to avoid any interference to the connections. The wires must also be hidden properly and insulated using electrical resistance materials to guarantee safety and reliable power distribution.

The electronics aspect of the system involves the sensor system which includes various sensors such as an inductive sensor that will be used to detect the presence of an aluminium can to trigger the crushing sequence. Besides that, magnetic sensors are used for each pneumatic cylinder to determine the state of the cylinders for the control logic to undergo the sequence accurately. These sensors are all connected to a programmable logic controller (PLC), which processes the inputs and outputs of the system. These will then control the conveyor belt and pneumatic cylinders motion, while also managing the timing of each action to prevent the crushing sequence from activating prematurely. The mechatronics aspect of the system involves integrating the mechanical components with the electronic components seamlessly to achieve automation. The system's pneumatic cylinder's crushing operation is coordinated with the sensors to enable automated operation which requires synchronising the sensors inputs and the solenoids outputs with the actuation of the cylinders. The PLC plays a key part in the process to ensure precise timing and control while also programmed to handle the logical flow of the operations.

2.3 Challenges Faced and Solution

One of the main challenges faced during the project was achieving the necessary force for the crushing operation while maintaining the system compact and intact. This was addressed by selecting a larger and stronger pneumatic cylinder that can exert larger force while using minimal energy. The crushing box also used thicker and higher quality wood to construct to ensure that it can withstand continuous stress from the cylinder. This allows the system to operate long term without the need for frequent maintenance. Another challenge faced was ensuring user safety in order to prevent accidents. To solve this, a kill-switch was implemented in the control panel which immediately stops the system operation and retracts all cylinders when actuated. Besides that, the system was unable to compress can of various sizes due to the limitation of detection range of the inductive sensor and cylinder stroke length. This affected the system's efficiency which means that the system can only crush a single type of can size. Theoretically, to overcome this, a scaled up version of the inductive sensor which has a larger detection range can be implemented. Also, a pneumatic cylinder with longer stroke length can be incorporated to ensure all cans of different height can be crushed properly.

Not only that, when first designing the logic of the operation for the PLC, we ran into various problems such as the sequencing order of the extension and retraction of cylinders were not accurate, this was solved by meticulous troubleshooting and designing a final TIA circuit that achieves the desired operations. Furthermore we also encountered a problem where while the crushing cylinder was extending, it glitches out in a way that it extends, retracts, extends and retracts again before crushing a can completely, this is solved by adding a Turn-On-Delay (TON) timer so that the cylinder does not retracts immediately after being detected by its magnetic sensor.

3.0 Results and Discussion

The Automated Can Crusher works as intended overall. The Funnelling Subsystem which consists of modified Acrylic Box works as it successfully channels products to the conveyor belt as well as sorting weighted products. The box successfully channels cans and other sorts of unwanted products while dispense objects that are generally heavier than empty cans.

Next, the Conveyor Subsystem also works as intended as it will be switched on, off and also reacts to emergency kill switch. As the switch is turned on, a green light will also be switched on indicating that the conveyor belt is activated. When the system is in default state or needs to be stopped, a stop button will be pressed, then a red light will be switched on to indicate the conveyor has stopped moving and the whole system has been halted. As mentioned earlier, this subsystem has a built-in kill switch emergency stop button. When this button is pressed, a yellow light will be switched on to indicate emergency status. All active subsystems will be halted and returned to their default state immediately upon pressing on the button. The system will remain in that state as long as the kill switch button is being reverted back to default state.

After that, the Can Sensing Subsystem also works as intended as functions to sort out aluminium cans and other unwanted products with its inductive sensor. Upon sensing an aluminium can, the inductive sensor will send out a signal to the PLC, and the conveyor will be halted. When other non-aluminium products have been sensed, the inductive sensor will not send a signal to the PLC.

Other than that, the Pushing Cylinder Subsystem that aimed to push the cylinder upon detecting an aluminium can into the crusher also works as intended. As mentioned in the previous subsystem, when the inductive sensor senses the aluminium can, the conveyor will be halted so that the pushing cylinder can push the can into the crusher.

Aside from that, the Crusher Subsystem also works as intended as it functions to crush a can upon detection with a magnetic sensor. The crusher is also being modified such that it has a built-in wooden box that serves as a place for the crushing. When the can has been pushed into the wooden box, a signal will be sent to the PLC with the help of magnetic sensors, this signal will then order the crushing pneumatic cylinder to extend forward, crushing the can as a result.

Finally, the Collection Box Subsystem works as intended where it functions to collect weighted unwanted products and crushed cans.

4.0 Recommendation and future work

There are many recommendations for future work after experiencing from working on this project. This project overall is very good in general as it teaches students to understand fundamental principles of some systems comprising of mechanical, electrical, electronic, computing and electro-mechanical sub-systems, with an intention to introduce cross-links between them for an integrated design approach towards their application to the development of complex systems. But the overall workload and time spent is greater than it should be since students need to band together to solve a complex problem: build an automated can crusher. The project is a good idea since students need to band together, spend a lot of time together just to achieve the same goal. But sometimes it's just too much, in order to just make a fully functioning project of all sorts, students tend to spend a lot of time, it’s not ideal and stressful at certain times of period.

Suggestion for future work is simply to reduce the requirements of the said projects. Since this unit is based more on projects and students teaming together, the requirements of the projects should scale based on the number of members of a team.

5.0 Discussion on Environmental and Sustainability Issues

This project has implemented pneumatic systems which mainly uses compressed air as the source of work. Compressed air is often considered a free or low-cost resource in industrial settings. However, this assumption is far from reality and rather uses of compressed air is expensive. Compressed air cost per cubic metre in MYR is 0.05112 MYR/. On the environmental impact side, the low efficiency of typical compressed air systems (10-15%) and the environmental consequences of this inefficiency.

Other than that, we should shed light on sustainability issues. The main issue of using compressed air is the low energy efficiency. We need to minimise the usage of compressed air. Firstly, we should store air close to the point of use. Basically, storing compressed air as close as possible to the point of use will minimise pressure loss due to flow resistances, reducing the need for a higher pressure setting at the compressor. This practice ensures that the energy is not wasted in transportation. Besides that, we should monitor and manage air usage. For example, we should be implementing a monitoring system to track compressed air usage in real time allowing for better management of resources. By understanding usage patterns, businesses can identify areas for improvement and implement targeted conservation strategies. After that, we should mount power control elements near working elements. By placing power control elements such as Direction Control Valves and Quick Exhaust Valves close to the actuators/ working elements, the system reduces the time and energy required to deliver compressed air. This proximity reduces the latency and increases the system response and efficiency. Finally, we should optimise pressure settings. For example, many compressed air systems operate at higher pressures than necessary. By carefully assessing the needs of each component and adjusting pressure settings accordingly, significant energy savings can be achieved. Lowering the pressure for elements with high air consumption is particularly effective. A pressure regulator dedicated to these components will quickly offset the ROI.

6.0 Conclusion

The Automated Can Crusher project met its primary aim of effectively compacting aluminium cans for recycling while minimising manual handling. By combining mechanical, electrical, electronic, and mechatronic components, the project creates a unified and functional design that automates the full can crushing process, from collecting to disposal. The system's pneumatic cylinders generate enough force to crush cans, while sensors and programmable logic controllers (PLCs) ensure exact timing and control of the process. The conveyor system, push cylinders, and safety systems all work together to keep users safe and operations running efficiently. Despite the challenges we encountered during the development process, we learnt a lot from it, which improved our understanding of the usage and function of each component.

Overall, the project was a good learning experience that included a range of technical disciplines and encouraged cooperation. With future advancements in energy efficiency and sustainability, the automated can crusher will be a viable waste management option in both residential and commercial settings, encouraging environmental protection and resource efficiency.

7.0 Reference

Bello, S.K. & Bajela, G.G. & Lamidi, Sheriff & Oshinlaja, S.. (2020). Design and Fabrication of Pneumatic Can Crushing Machine. International Journal of Advances in Scientific Research and Engineering. https://www.researchgate.net/publication/346843700_Design_and_Fabrication_of_Pneumatic_Can_Crushing_Machine

Chakule, Rahul & Patil, Supriya & Talmale, Poonam. (2020). Design and Development of Can Crushing Machine. Asian Journal of Engineering and Applied Technology. https://www.researchgate.net/publication/353926275_Design_and_Development_of_Can_Crushing_Machine

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Appendix A - System Hierarchy

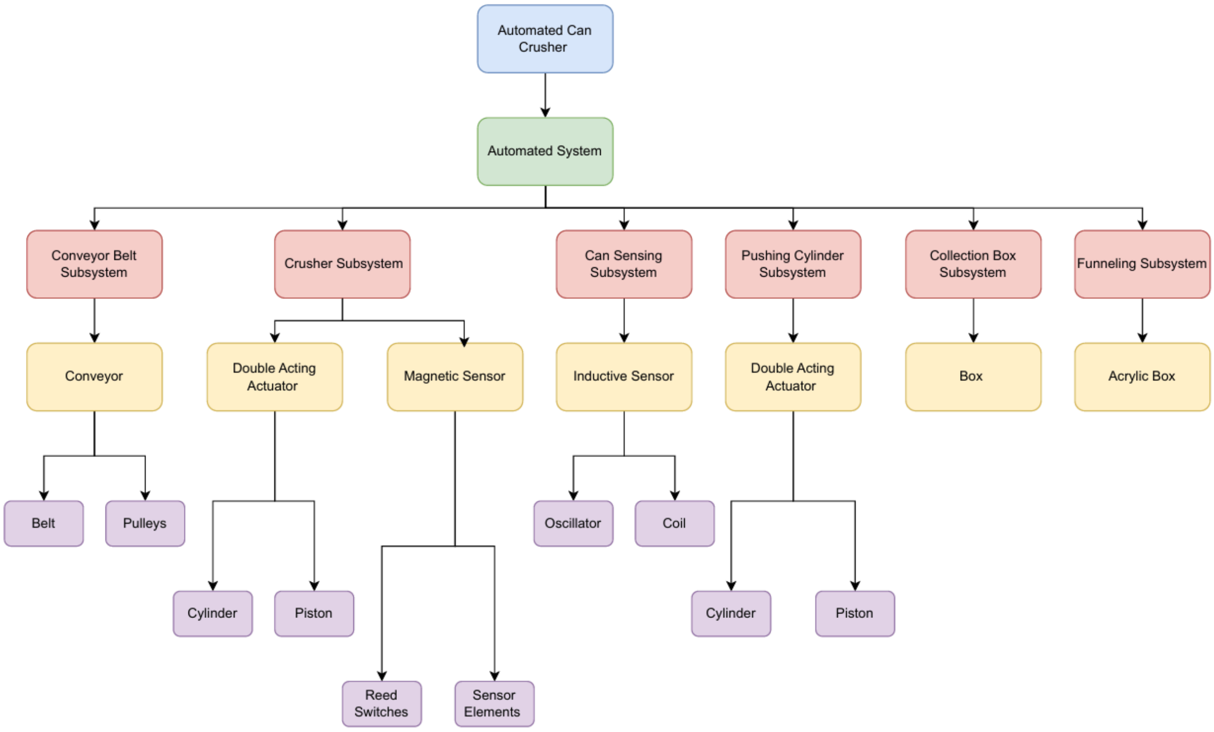


Figure 15: System Hierarchy

Appendix B - Bill of Materials and Expenses Tracking

Outsource - Purchase Ourself
Insource - Borrow from lab tech
Manufacture -

Request				Tracking			
	Component Name	Specification	QTY	Source	Unit Price (RM)	Total (RM)	Status
1	Hinge	Either buy or 3D print depends on the final design dimension	2	Out - source	5	10	Done
2	Single Acting Cylinder with spring return (Magnetic Sensor)	Extension Length: 160mm ± 10mm	2	In- source	593.01	1186.02	Done
3	Double Acting Cylinder (Magnetic Sensor)	Extension Length: 160mm ± 10mm	2	In- source	777.92	1555.84	Done
4	Bolts	Bolt & Nut Shop	50	Out - source	0.20	10	Done
5	Nuts	Bolt & Nut Shop	50	Out - source	0.20	10	Done
6	Conveyor Belts	Variable Speed	1	In- source	1160	1160	Done
7	Quick Exhaust Valve	Nil	2	In- source	73.98	147.96	Done
8	One Way Throttle Valve	Nil	2	In- source	114.36	228.72	Done
9	PLC	Siemens PLC 1214C AC/DC/RLY	1	Insource	1113.72	1113.72	Done
10	Metal Inductive Sensor	Detection Range approx.20 mm	2	Insource	16	16	Done

11	Aluminium Profile Extruded Bar	Nil	3	Insource	101.29	303.88	Don e
12	Aluminium Extruded Bar Bracket.	Nil	10	Insource	10.90	109.00	Don e
13	Aluminium Mounting Panel	Nil	1	Insource	634.50	634.50	Don e
14	Aluminium profile base	Nil	1	Insource	341.62	341.62	Don e
15	Wooden crushing compartment	None	1	Manufacture	42.17	42.17	Don e
16	Funnel	Width of Can	1	Manufacture	32.62	32.62	Don e
17	FRL unit	None	1	Insource	133.33	133.33	Don e
18	Solenoid Actuated Double External Pilot Valve	None	2	Insource	146.26	292.52	Don e
19	AC-DC Converter	240V to 24V	1	Insource	203.06	203.06	Don e
20	Solid State Relay	None	1	Insource	7.95	7.95	Don e
21	Control panel	Start, stop and kill switch buttons with respective lights.	1	Manufacture	37.25	37.25	Don e

Table 1: Bill of Material

Appendix C - Technical Drawings

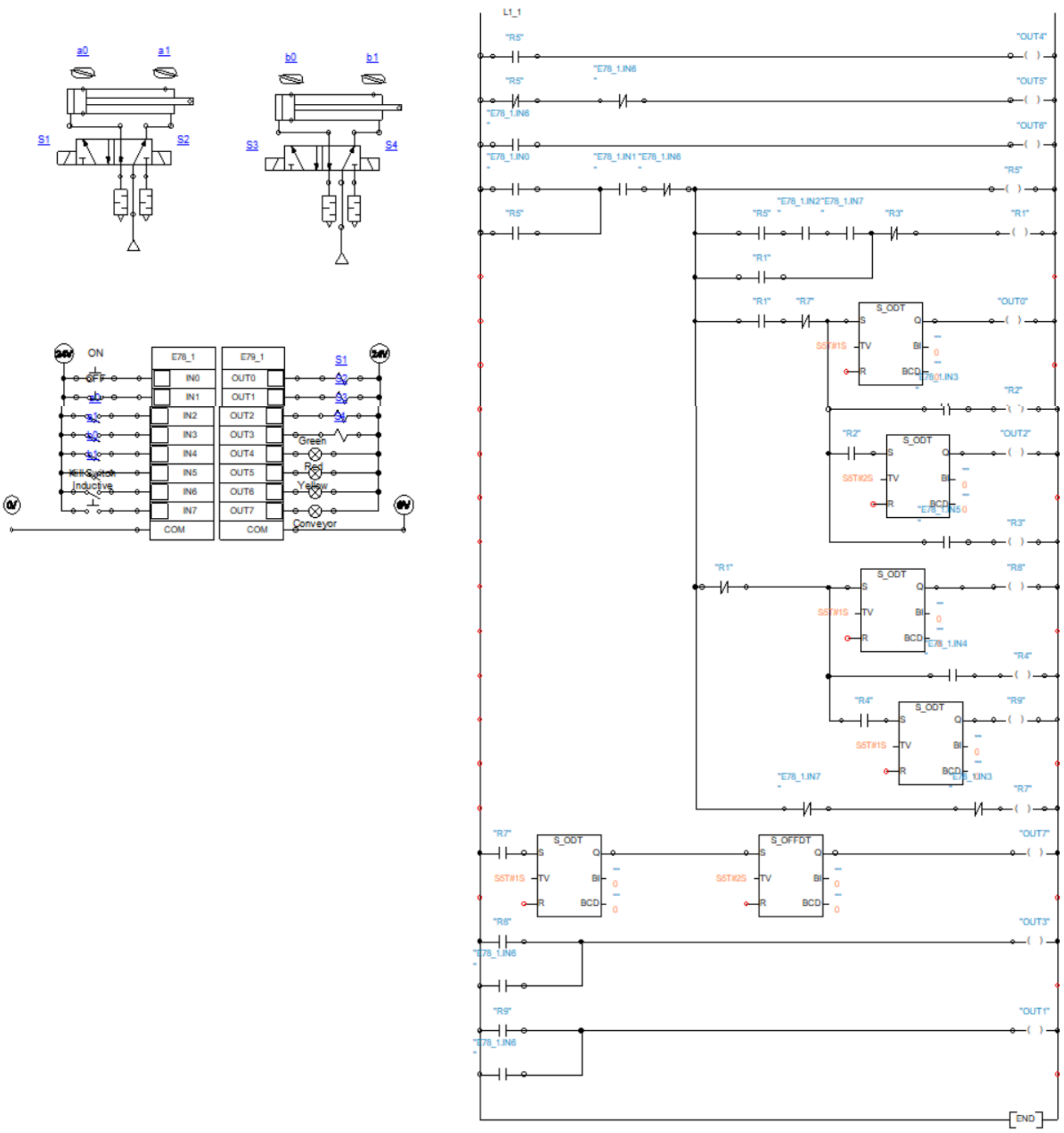
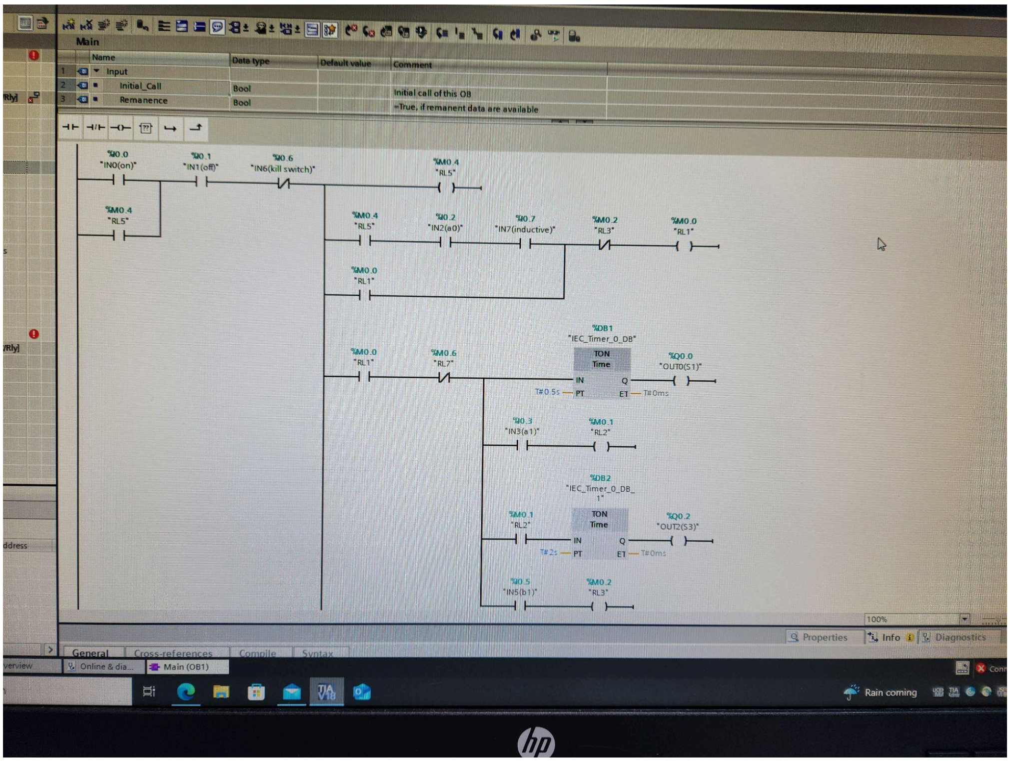
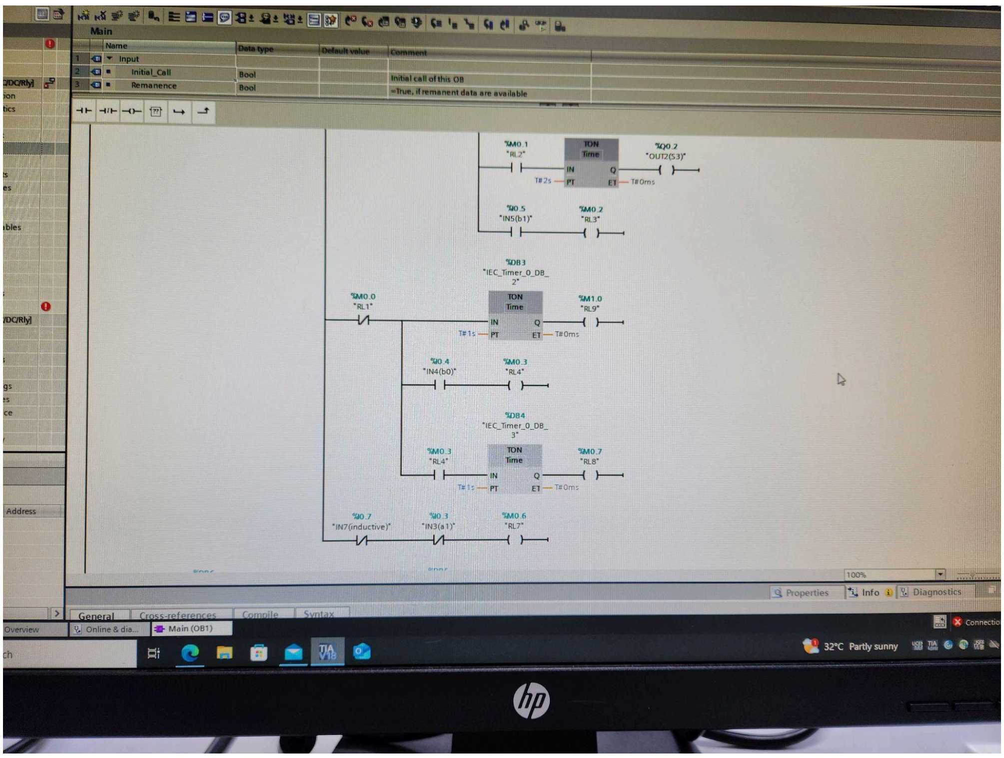
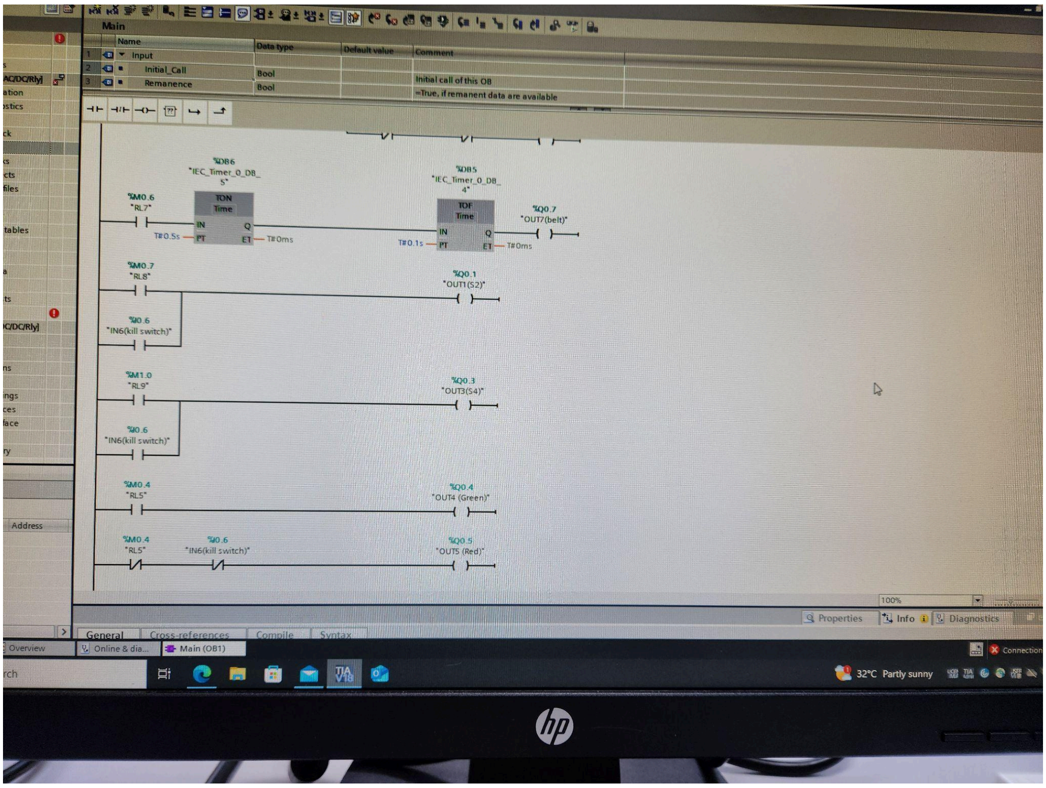


Figure 16: AS Drawing of Design

Appendix D - PLC Program







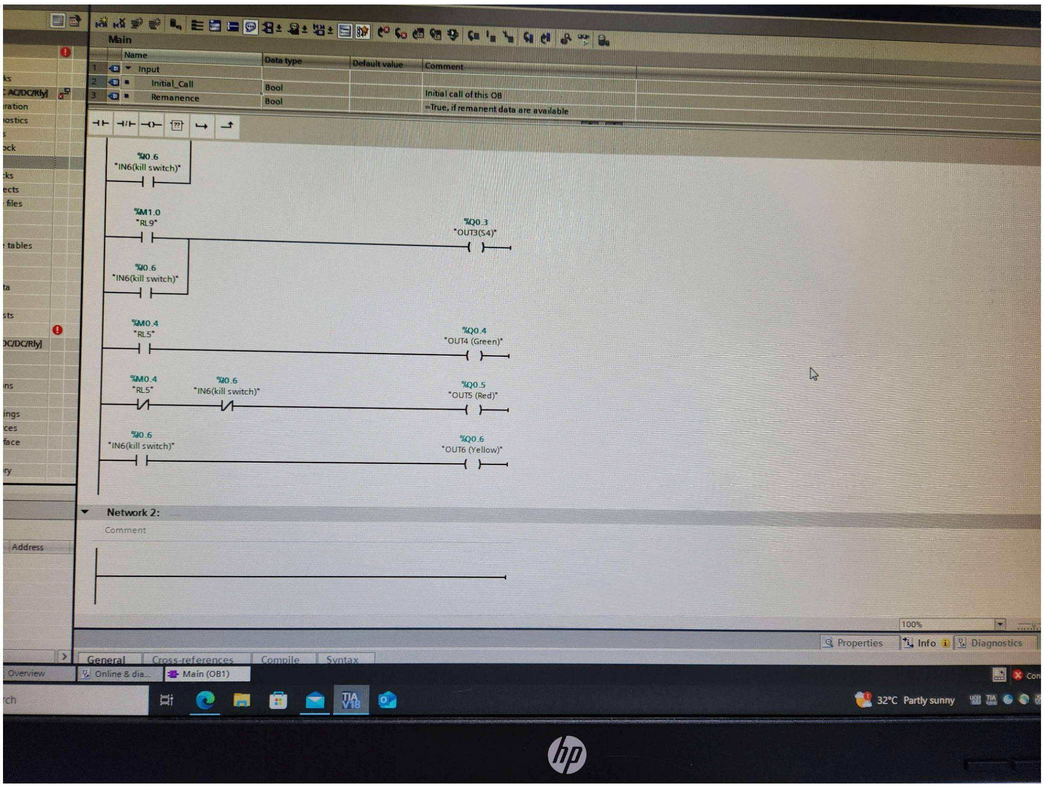


Figure 17-20: PLC Program

Appendix E - Technical Roles and Non-technical Roles

Team Name: The Special Group
Tentative Project Title: Automated Can Crusher (ACC)

Team Members:

Technical Roles:		**Non-technical Roles:**	
Role	**(ID) Full Name**	**Role**	**(ID) Full Name**
Mechanical / CAD Designer	Lim Yap Khye	Project Manager	Lim Yap Khye
Pneumatic Designer	Chong Zheng You	Documentation Manager	Chong Zheng You
Electrical System Designer	Lim Wei Neng	Accountant	Lim Wei Neng
Electro-pneumatic Designer	Jacky Hu	Human Relations Manager (HR)	Jacky Hu
TIA Specialist / Programmer	Sharvin Gupta	Quality Assurance Manager	Sharvin Gupta

Table 2: List of Roles

Appendix F - Responsibility Matrix

Group Members Name:
M1: Lim Yap Khye
M2: Chong Zheng You
M3: Lim Wei Neng
M4: Sharvin Gupta
M5: Jacky Hu

P - Primary Responsibility, S - Secondary Responsibility

Tasks (from WBS)	M1	M2	M3	M4	M5
Procuring Materials	P	P	S	S	S
Flowchart Design	S	S	P	P	S
Poster	P	P	P	P	P
System Hierarchy	S	S	P	S	S
Alternative Designs	P	S	S	P	S
Assemble of system components	P	P	S	S	S
Building of system	P	P	P	P	P
Programming	P	P	P	P	P
Testing	P	P	P	P	P
Documentation of progress	P	P	P	P	P

Table 3: Responsibility Matrix

Appendix G - Work Breakdown Structure

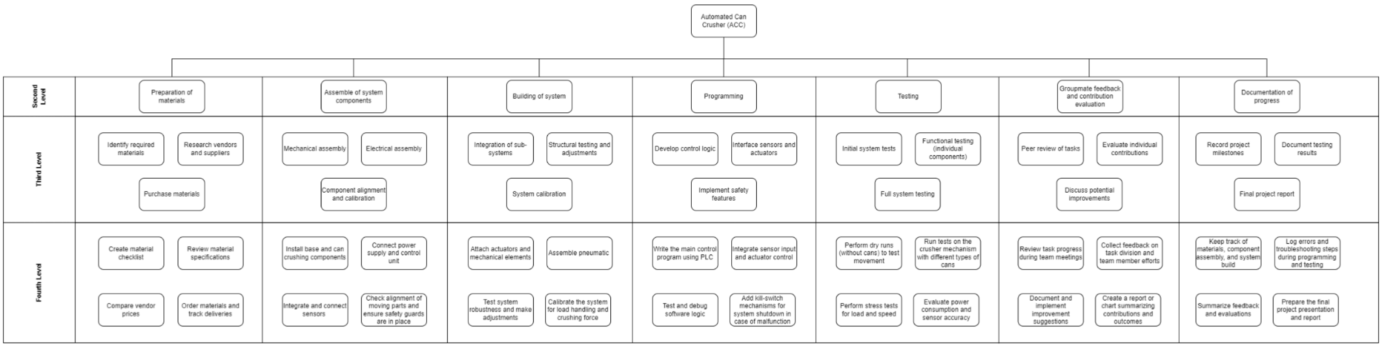


Figure 21: Work Breakdown Structure

Appendix H - Gantt Chart

GANTT CHART TEMPLATE

PROJECT TITLE	Automated Can Crusher
PROJECT MANAGER	Lim Yap Khye
COMPANY NAME	Group 14
DATE	13-10-2024

TASK ID	TASK TITLE	START DATE	DUE DATE	DURATION IN DAYS	PCT OF TASK COMPLETE
1.0	Preparation of materials	2/9/24	12/10/2024	40	100%
2.0	Assemble of system components	2/9/24	12/10/2024	40	100%
3.0	Building of system	30/9/24	18/10/24	20	100%
4.0	Programming	20/9/24	07/10/24	17	100%
5.0	Testing	14/10/24	18/10/24	4	100%
6.0	Groupmate feedback and contribution evaluation	14/10/24	18/10/24	4	100%
7.0	**Documentation of progress**	07/10/24	18/10/24	11	100%

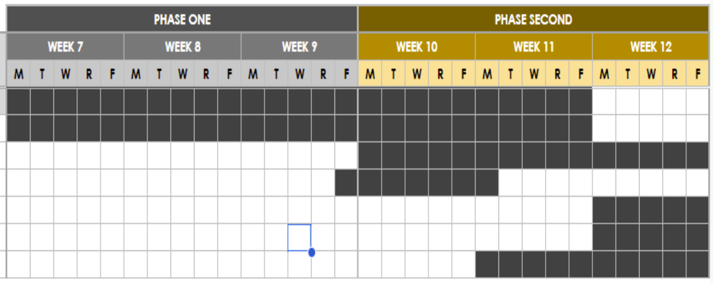


Figure 22: Gantt Chart

Appendix I - Logbook

Team Name:	The Special Group
Group Number:	14
Team Members:	1) Lim Yap Khye
	2) Chong Zheng You
	3) Sharvin
	4) Lim Wei Neng
	5) Jacky Hu

Week 3 Project Log:

Period: 4 AUG 2024 - 10 AUG 2024
Review: 1. Although the number of group members is still in flux, we have roughly defined the division of labour between software and hardware. Two members are mechanical engineering, one is electrical engineering, and two are mechatronics engineering. The mechanical engineers will design the components and main mechanisms, while the rest of the group will handle programming and debugging. 2. Starting this week, we started to prepare for the planning. We need to refer to the previous projects done by the seniors and make a list of projects of what we want to accomplish.
Achievements: 1. (Group14) Reading seniors' projects and briefly getting the ideas of how the final project will be.
Action Plan: 1. Brainstorm ideas of what we are going to do for our project. (PIC: Group14 , Due Date: 17 AUG 2024, 11:59pm)

Week 4 Project Log:

Period: 11 AUG 2024 - 17 AUG 2024
Review: 1. Brainstorm ideas of what we are going to do for our project. (PIC: Group14, Due Date: 17 AUG 2024, 11:59pm, Outcome: extend to 24 AUG 2024, 11:59pm)
Achievements: 1. (Group14) Come out with the idea of “Tin crusher” but the details of it still need to be considered.
Action Plan: 1. Details of “Tin crusher”. (PIC: Group14, Due Date: 24 AUG 2024, 11:59pm) 2. Learn how to use Automation Studio to build and simulate circuits. (PIC: Group14, Due Date: 31 AUG 2024, 11:59pm)

Week 5 Project Log:

Period: 18 AUG 2024 - 24 AUG 2024
Review: 1. Brainstorm ideas of what we are going to do for our project. (PIC: Group14, Due Date: 24 AUG 2024, 11:59pm, Outcome: completed) 2. Details of “Tin crusher”. (PIC: Group14, Due Date: 24 AUG 2024, 11:59pm, Outcome: completed) 3. Learn how to use Automation Studio to build and simulate circuits. (PIC: Group14, Due Date: 31 AUG 2024, 11:59pm, Outcome: in progress)
Achievements: 1. (Group14) After careful consideration, we have decided to build a “Tin crusher” as our project. 2. (Group14) The system will use two cylinders and one sensor to sort and compress the cans. 3. (Group14) We still learn to use Automation Studio and get used to it. There are more components we need to know.
Action Plan: 1. Design of compression chamber on Solidworks and methods of sorting. (PIC: YKLim, ZYChong, Due Date: 31 AUG 2024, 11:59pm) 2. Design of the funnel for putting cans on the conveyor belt. (PIC: YKLim, ZYChong, Due Date: 31 AUG 2024, 11:59pm)

Week 6 Project Log:

Period: 25 AUG 2024 - 31 AUG 2024
Review: 1. Learn how to use Automation Studio to build and simulate circuits. (PIC: Group14, Due Date: 31 AUG 2024, 11:59pm, Outcome: completed) 2. Design of compression chamber on Solidworks and methods of sorting. (PIC: YKLim, ZYChong, Due Date: 31 AUG 2024, Outcome: completed) 3. Design of the funnel for putting cans on the conveyor belt. (PIC: YKLim, ZYChong, Due Date: 31 AUG 2024, 11:59pm, Outcome: completed)
Achievements: 1. (Group14) We all know how to use AS to build complex circuits and simulate them. 2. (YKLim, ZYChong) The outline of the compression chamber has been designed and has two designs for different sizes of cans which we still need to consider later. 3. (YKLim, ZYChong) The outline of the funnel has been designed, but the size is pending on the layout of our project system.
Action Plan: 1. Learn how to use Automation Studio to build PLC circuits. (PIC: Group14, Due Date: 7 SEP 2024, 11:59pm) 2. Try to build the AS circuit of the project according to the IDA circuit. (PIC: WNLim, Due Date: 7 SEP 2024, 11:59pm) 3. Online Group meeting (PIC: Group14, Date: 1 SEP 2024, 10:00pm)

Week 7 Project Log:

Period: 1 SEP 2024 - 7 SEP 2024
Review: 1. Learn how to use Automation Studio to build PLC circuits. (PIC: Group14, Due Date: 7 SEP 2024, 11:59pm, Outcome: extended to 14 SEP 2024, 11:59pm) 2. Try to build the AS circuit of the project according to the IDA circuit. (PIC: WNLim, Due Date: 7 SEP 2024, 11:59pm, Outcome: extend to 14 SEP 2024, 11:59pm)
Achievements: 1. (Group14) Each member has already had some idea of how PLC works but obviously we

need more time to digest what we've learnt (since it's harder than we thought). 2. (WNLim) Logic thinking is hard, therefore, extended for 1 week to take time thinking of the system logic. 3.
Action Plan: 1. Start preparing the components and materials we are going to use. (PIC: YKLim, ZYChong, Due Date: 21 SEP 2024, 11:59pm) 2. Learn how to startup and use TIA to build and simulate circuits. (PIC: SGupta, JHu, Due Date: 14 SEP 2024, 11:59pm)

Week 8 Project Log:

Period: 8 SEP 2024 - 14 SEP 2024
Review: 1. Learn how to use Automation Studio to build PLC circuits. (PIC: Group14, Due Date: 14 SEP 2024, 11:59pm, Outcome: completed) 2. Try to build the AS circuit of the project according to the IDA circuit. (PIC: WNLim, Due Date: 14 SEP 2024, 11:59pm, Outcome: extend to 21 SEP 2024, 11:59pm) 3. Start preparing the components and materials we are going to use. (PIC: YKLim, ZYChong, Due Date: 21 SEP 2024, 11:59pm, Outcome: in progress) 4. Learn how to startup and use TIA to build and simulate circuits. (PIC: SGupta, JHu, Due Date: 14 SEP 2024, 11:59pm, Outcome: completed)
Achievements: 1. (Group14) All members are familiar with how the PLC works and how to build PLC circuits in AS. 2. (WNLim) We have made some changes in the project circuit, so we need to make corresponding changes in AS. 3. (YKLim, ZYChong) Most of the materials and components are delivered but we are waiting for the inductive sensor to start planning the layout of the project. 4. (SGupta, JHu) SGupta is familiar with TIA manipulation whereas JHu needs to practise more on it.
Action Plan: 1. Starting to build a brief circuit on TIA based on the AS circuit. (PIC: SGupta, JHu, Due Date: 21 SEP 2024, 11:59pm) 2. Online Group meeting (PIC: Group14, Date: 15 SEP 2024, 10:00pm)

Week 9 Project Log:

<table>
<tr><td>Period: 15 SEP 2024 - 21 SEP 2024</td></tr>
<tr><td>Review:
1. Try to build the AS circuit of the project according to the IDA circuit. (PIC: WNLim, Due Date: 21 SEP 2024, 11:59pm, Outcome: completed)
2. Start preparing the components and materials we are going to use. (PIC: YKLim, ZYChong, Due Date: 21 SEP 2024, 11:59pm, Outcome: completed)
3. Starting to build the circuit on TIA based on the AS circuit. (PIC: SGupta, JHu, Due Date: 21 SEP 2024, 11:59pm, Outcome: completed)</td></tr>
<tr><td>Achievements:
1. (WNLim) Finished building the circuit in AS.
2. (YKLim, ZYChong) All components and materials are received and we can start building the system.
3. (SGupta, JHu) Finished building the circuit in TIA.</td></tr>
<tr><td>Action Plan:
1. Build the actual circuits in the lab and test it (PIC: SGupta, YKLim, Due Date: 5 OCT 2024, 11:59pm)
2. Build the junction box. (PIC: YKLim, WNLim, Due Date: 5 OCT 2024, 11:59pm)
3. Build the compression chamber and funnel (PIC: YKLim, ZYChong,Due Date: 5 OCT 2024, 11:59pm)</td></tr>
</table>

Week 10 Project Log:

<table>
<tr><td>Period: 29 SEP 2024 - 5 OCT 2024</td></tr>
<tr><td>Review:
1. Build the actual circuits in the lab and test it (PIC: SGupta, YKLim, Due Date: 5 OCT 2024, 11:59pm, Outcome: extend to 12 OCT 2024, 11:59pm)
2. Build the junction box. (PIC: YKLim, WNLim, Due Date: 5 OCT 2024, 11:59pm, Outcome: completed)
3. Build the compression chamber and funnel (PIC: YKLim, ZYChong, Due Date: 5 OCT 2024, 11:59pm, Outcome: completed)</td></tr>
<tr><td>Achievements:
1. (SGupta, YKLim) Something goes wrong in the output which needs to be fixed this week.
2. (YKLim, WNLim) The junction box is built and labelled, and ready to be connected to the circuits.
3. (YKLim, ZYChong)The compression chamber and funnel is built and ready to be placed.</td></tr>
<tr><td>Action Plan:
1. Build the whole circuit according to the TIA and AS circuits (PIC: Group14, Due Date: 12 OCT 2024, 11:59pm)
2. Online Group meeting (PIC: Group14, Date: 6 OCT 2024, 10:00pm)</td></tr>
</table>

Week 11 Project Log:

Period: 6 OCT 2024 - 12 OCT 2024
Review: 1. Build the actual circuits in the lab and test it (PIC: SGupta, YKLim, Due Date: 12 OCT 2024, 11:59pm, Outcome: completed) 2. Build the whole circuit according to the TIA and AS circuits (PIC: Group14, Due Date: 12 OCT 2024, 11:59pm, Outcome: completed)
Achievements: 1. (SGupta, JHu) It was found that you can't have two identical outputs at the same time, as this affects the final output. Changes have been made to fix the problem. 2. (Group14) Finished building all the circuits in the system and ready for testing. 3.
Action Plan: 1. Test and finalise the circuit. (PIC: Group14, Due Date: 19 OCT 2024, 11:59pm) 2. Adjust positions of the components to allow the system to work smoothly. (PIC: Group14, Due Date: 19 OCT 2024, 11:59pm) 3. Ensure safety standards are met. (PIC: Group14, Due Date: 19 OCT 2024, 11:59pm) 4. Ensure presentation criterias are discussed and accounted for before the final preparations. (PIC: Group14, Due Date: 19 OCT 2024, 11:59pm)

Week 12 Project Log:

Period: 13 OCT 2023 - 19 OCT 2023
Review: 1. Test and finalise the circuit. (PIC: Group14, Due Date: 19 OCT 2024, 11:59pm, Outcome: completed) 2. Adjust positions of the components to allow the system to work smoothly. (PIC: Group14, Due Date: 19 OCT 2024, 11:59pm, Outcome: completed) 3. Ensure safety standards are met. (PIC: Group14, Due Date: 19 OCT 2024, 11:59pm, Outcome: completed) 4. Ensure presentation criterias are discussed and accounted for before the final preparations. (PIC: Group14, Due Date: 19 OCT 2024, 11:59pm, Outcome: completed)
Achievements: 1. Safety Standards are upheld and achieved. 2. Presentation script developed. 3. Circuit works as intended.
Action Plan: 1. Prepare project for the presentation (PIC: Group14, Due Date: 20 OCT 2024, 11:59pm) 2. Take a group picture in front of the completed project. 3. Practice presentation with script