



College of Engineering

Department of Electro-Mechanical Engineering

Internship [EMEG4116]

**AUTOMATED CUTTER ACTIVATION SYSTEM BY USING
PHOTOELECTRIC SENSOR, RELAYS AND PUSH BUTTONS**

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Approval Page

Addis Ababa Science and Technology University

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Declaration

I, Kaleab Gashaw, a student of Electromechanical Engineering at Addis Ababa Science and Technology University, hereby declare that the internship report is my original work.

This report has not been submitted, in whole or in part, to any other institution for academic or professional credit or any other purpose. The conclusions and suggestions presented in this report are solely my own and do not reflect the views of Excel Plastics PLC.

I confirm this report adheres to the internship report writing guidelines provided by Addis Ababa Science and Technology University.

Name of Student

Date

Signature

...../...../.....



Acknowledgment

I humbly extend my utmost gratitude to the Almighty for His unwavering blessings and guidance throughout my academic endeavors.

I am profoundly grateful to Addis Ababa Science and Technology University for granting me the invaluable opportunity to partake in their esteemed internship program. This transformative experience has profoundly enriched my skill set and knowledge in the field of Technical and Electrical Technician.

My sincere appreciation goes to Excel Plastics PLC for generously embracing me as an intern and offering me invaluable real-world experience through their cutting-edge projects and practices.

I owe a debt of gratitude to my academic advisor, Mr. Daniel Abebe, for his unwavering support, mentorship, and incisive feedback, which have played an instrumental role in shaping the depth and quality of this report. Moreover, I wish to express my heartfelt gratitude to my company advisor, Mr. Wubayehu Negash, for his invaluable guidance and practical insights throughout my internship.

Finally, I wholeheartedly acknowledge and appreciate the contributions of all those who have supported me in the completion of this report. Their unwavering support, encouragement, and constructive feedback have been pivotal in its development. I extend my sincerest thanks to everyone who has played a part in my academic and professional growth.



Executive Summary

My three-month internship at Excel Plastics PLC, Ethiopia's largest UPVC and HDPE pipe producer, aimed to translate my theoretical electromechanical engineering knowledge (Addis Ababa Science and Technology University) into practical skills. Working within the Technical Department's electrical section, I gained hands-on experience with extrusion, blow molding, and injection molding machines, alongside PLCs, HMIs, and various sensors. This involved directly participating in daily operations, troubleshooting equipment, and understanding the entire production process. The report details these machines' functions and their role in Excel Plastics' production.

This practical experience was crucial for bridging the gap between theory and practice. It fostered the development of essential skills, including troubleshooting, teamwork, and problem-solving, while providing insights into industrial workplace ethics. Overcoming challenges related to the complexity of machinery and the fast-paced environment further enhanced my capabilities.

The internship's significance lies in its direct contribution to my professional development. The acquired practical skills and in-depth understanding of industrial processes are directly applicable to my future career, making me a more competitive and knowledgeable graduate. The detailed report also offers valuable insights into the Ethiopian manufacturing sector.



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Acronyms and Symbols of Definition

AASTU	Addis Ababa Science and Technology University
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
BS	British Standard
DIN	Deutsches Institut für Normung (German Institute for Standardization)
HDPE	High-Density Polyethylene
HMI	Human Machine Interface
ICRC	International Committee of the Red Cross
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
NGO	Non-governmental organization
OSHA	Occupational Safety and Health Administration
PLC	Programmable Logic Controller
PVC	Polyvinyl Chloride
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Fund
UPVC	Unplasticized Polyvinyl Chloride
VAC	Volts Alternating Current
VDC	Volts Direct Current



Chapter One

1 Introduction

1.1 Brief History

Excel Plastics Private Limited Company was established in 1986 E.C between two shareholders: Ato Tenna Kebede and Ato Wondwossen Ketema as per the Commercial Code of Ethiopia. At the time of its establishment, the business aim of the company was to produce various types of households, institutional hand-washing plastic products, and industrial containers.

Over the years the company has been delivering top-quality solutions in plastic household items as well as industrial containers it is a Company of Extraordinary Vision that truly understands and recognizes the importance of plastic pipes, the role they play in economic development, and in the creation of a better Ethiopia. Its initiative, strategy, and dedication resulted in installing the latest high-technology equipment such as single and Twin-Screw Extrusion plants in 2001E.C.

This helps the Company to manufacture UPVC (UN plasticized Polyvinyl Chloride) and H.D.P.E (High-Density Polyethylene) pipe systems with the highest quality standards. These Plastic pipes are used for Water Distribution Networks, Irrigation, Drainage, Sewerage, Construction, Telecommunication, and Electrical installation systems. Most importantly they can handle water from the source to the end-use and from the end-use to the disposal. Plastic Pipes help control the ecosystem with perfection and care and keep in view the present and future concerns for water.

As they have always been doing since our establishment, they mean to be practical partners in the development of Ethiopia. Our type of business is very closely linked with the eradication of poverty and self-sufficiency in the production of food. They pledge this much and more.

Excel Plastics Plc now is investing in state-of-the-art technology to produce genuine world-class UPVC and HDPE pipe products from quality raw materials supplied by foreign companies that are certified with ISO 9001:2015.

Due to these facts, they have now become the largest producer of these products in Ethiopia. No wonder, today our UPVC and HDPE pipe products have a significant presence in the domestic markets and are helping in the various Development Projects in the Country.



The production facilities have been expanded to cover an area over 26000m². Today the company is a major manufacturer of a wide range of high-quality plastic pipe systems, and a distributor of Pipe, adhesives, and specialty products. The product range of Excel Plastics plc has been continually developed and now includes items for many applications across many fields then, currently they are producing different hoses and conduits such as Suction hoses, Garden hoses, Lay flat hoses, braided, flexible conduit, and rigid conduit hose. Excel Plastic products are distributed and marketed in all Ethiopian regions and are made in strict compliance with various international standards. (ASTM, BS, ISO, DIN).

As a company committed to quality. Excel Plastics Quality management system has been assessed by DQS and registered against the requirements of BS EN 150 9001:2015 Quality management system by IQNET in the international certification network System, and hence, it is registered with the International Certification Network.

Excel Plastics plc is the Pioneer in plastic molding in Ethiopia. Incorporated in 2001 E.C. They have fast captured the imagination of the people in Ethiopia and the neighboring countries in East Africa. The company over the decade has tech wide range of machinery named blow and injection to produce and supply.

The company has also formed strategic alliances with several other leading manufacturers to complement its range of products and is thus able to offer the most complete range of products and services to its end-user customers. EXCEL Plastics will continue to strive to produce products of the highest quality that is reliable, and competitive; offer good value, and meet the specific needs of its customers.

1.2 Vision

Excel Plastics PLC aspired to become the best plastics product manufacturer. by adapting quality-based and customer-oriented workmanship using appropriate technology to become one of the leaders in local and international competitive markets.

1.3 Mission

Excel Plastics PLC was established, to provide quality plastic products and services to society that create additional Value for stakeholders and satisfy our customers by supplying quality plastic products at reasonable prices.

1.4 Value of the company

The values of Excel Plastics plc are beliefs, which are upheld in common by its employees and management to put them into practice. They are the cumulative effect of personal and professional values which are shared and owned by all. Hence, the values are expressed by the staff of the enterprise as follows: Team spirit, Integrity, Customer focus, and Transparency. Environment sensitivity, and Commitment.

1.5 Objectives

The objective of the establishment of the company includes the following:

- To produce UPVC, HDPE, SUCTION HOSE, and PVC GARDEN HOSE high and medium pressure pipes of different sizes both in diameter and thickness as per DIN 8062 and BS 3505, ISO 4422, ISO 1611, ISO 4427, etc.
- To perform all kinds of commercial transactions which are connected and related to the objective of the company.
- To make investments in companies having similar objectives.
- To implement new projects and factory extensions.
- Looking for joint venture opportunities.
- To help the Ethiopian economy by saving hard currency based on import substitution.
- To diversify the manufacturing system to produce engineering plastics.

1.6 Products of the Company

Excel plastic products categories include a wide range of high-quality plastic products. Displayed in the following figure:



Figure 1.1 Products of the company (Adapted from Company Website)



1.7 Main Customer or End Users

EXCEL Plastic PLC's clientele encompasses a diverse range of organizations, reflecting the company's significant presence within the water, sanitation, and humanitarian sectors. Key partners include prominent international NGOs such as OXFAM, World Vision, UNICEF, UNHCR, ICRC, and Mercy Corps, alongside national-level actors like the Ethiopia Somali Regional State Water Resource Development Bureau. Furthermore, EXCEL Plastic PLC collaborates with prominent construction and engineering firms such as Salini Impregilo and Gebecon PLC, and specialized water technology providers like Water FIT and Fluid Engineering and Trading PLC. This broad partnership network underscores EXCEL Plastic PLC's established position within a complex ecosystem of actors contributing to water resource management and humanitarian aid delivery in the region.

1.8 Organizational Structure

Organizational Structure is the invisible framework that guides how a company functions, defining lines of authority, division of labor, communication channels, and resource allocation. It's the backbone of success, ensuring tasks are effectively divided, roles are clearly assigned, and information flows smoothly, allowing individuals to navigate their roles, collaborate seamlessly, and contribute to the overall goals of the organization.

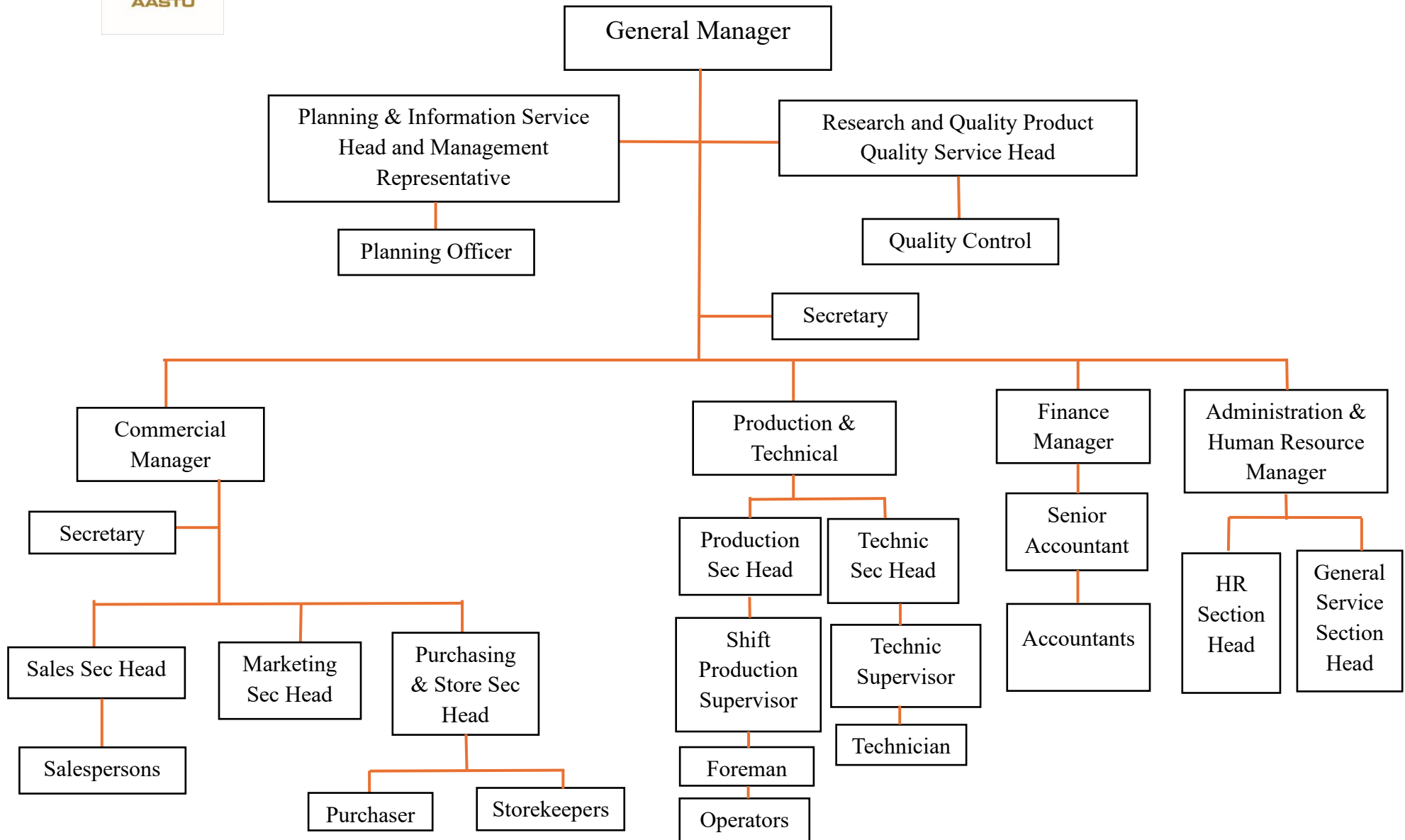


Figure 1.2 Organizational structure of the company (Adapted from Company Profile)



Chapter Two

2 Overall, About the Excel Plastics and the Internship

2.1 General Objective of the Internship

The primary objective of the internship is to apply the theoretical knowledge acquired in the classroom to practical, real-world contexts. It also presents an opportunity for us to cultivate essential workplace skills, including communication, teamwork, problem-solving, and time management. Additionally, internships enable us to demonstrate our skills and capabilities to potential employers, which may result in job offers upon graduation. Beyond these advantages, the internship serves to provide insights into the inner workings of our chosen field, foster relationships with professional mentors, network with prospective employers, develop our professional identity, and enhance our confidence and self-assurance. In summary, internships represent a valuable experience for students at all levels. They offer a distinctive opportunity to learn and grow within a professional environment while acquiring important skills and experiences that can facilitate the launch of successful careers.

2.2 My First Impression of Excel Plastics

2.2.1 Introduction

On July 3, 2024, I began my internship at Excel Plastics PLC. This report outlines my initial experiences, tasks, and the insights gained during my time at the company.

2.2.2 Orientation And Initial Meeting

My first task was to meet with the General Manager. This session provided an overview of the company's profile, along with guidelines on conduct during the internship. I was informed about the company's duties, regulations, and the necessity of acquiring personal safety equipment for the workplace.

2.2.3 Human Resources and Supervisor Introduction

Following the meeting, I was directed to the Human Resources Manager to commence the program. An Industry Supervisor was assigned to me, who conducted a comprehensive tour of the company. This introduction was crucial for familiarizing myself with the company's environment and workspace layout.



2.2.4 Department Assignment (Technical Department)

I was assigned to the Technical Department, specifically the electrical section. My tenure here lasted three months, during which I gained substantial experience in electrical tasks. To broaden my understanding, I also spent time in the mechanical and operations departments.

2.3 Common Devices and Components Used in the Excel Factory

The company of Excel Plastics utilizes a variety of machines and components to perform their desired tasks. These machines are synchronized to work together efficiently across the electrical and mechanical departments.

2.3.1 Common Machines

The company categorizes its machines into three main types:

1, Extrusion machines

2, Blow machines

3, Injection machines

Each type performs different activities. Additionally, the company employs several supporting machines, including:

- Laser machine
- Welding machines (electric and gas)
- Milling machine
- Shaper machine
- Drilling machine
- Hydraulic press
- Pedestal grinding machine
- Portable hand grinding machine
- Power axe hall

2.3.2 Common Components

The basic machines utilize various components to function effectively. Some of the most common components are:

➤ **Programmable Logic Control (PLC)**

PLCs are special controllers that use programmable memory to store instructions and implement functions such as logic, arithmetic, timing, sequencing, and counting. They control different types of machines based on their purpose and functions. The company primarily uses Siemens PLCs to control motors, pumps, pneumatic valves, solenoid valves, and hydraulic systems. PLCs receive data from sensors for feedback and use this data to respond to the required intended result by sending signals to output devices.

➤ **Human Machine Interface (HMI)**

HMIs are essential tools that allow workers, such as operators, technicians, and engineers, to communicate with the machines. They typically use touchscreen displays for ease of access but may also include manual push buttons. HMIs provide different levels of access, allowing individuals to control the machines clearly and easily.

➤ **Sensors**

Sensors are input devices that provide a usable output in response to a specified physical input. They provide feedback information for the PLC in the form of alarms or other display methods. Sensors are crucial for the complete automation of machines. Some common sensors used by the company include:

- ❖ **Proximity sensors:** Inductive sensors that detect metallic objects. When the objects are attached to the sensor, their movement is detected, and the sensor sends signals to the PLC.
- ❖ **Temperature sensors (thermocouples):** Devices that measure and convert the temperature of an object into an electrical signal that can be read by a measurement or controlling system. They work on the Seebeck effect, where a small voltage is generated proportional to the temperature difference between the two junctions of dissimilar metals.
- ❖ **Water level sensors (conductive sensors):** Devices used to detect and measure the level of water or other liquids in a tank. They consist of three electrodes (typically made of stainless steel or other corrosion-resistant materials) inserted into the container at different depths. One rod is designated as the common or ground electrode, while the other two are used as the high- and low-level electrodes. When the water level reaches the low-level electrode, it creates a conductive path between

the low-level electrode and the common electrode, completing a circuit. A similar process occurs when the water level reaches the high-level electrode.

- ❖ **Pressure sensors (differential type):** These sensors work based on the relationship between the applied pressure and the resulting change in physical property that can be measured and converted into an electrical signal.

2.4 Overall descriptions and working principles of the three basic machines

2.4.1 Extrusion machines

Extrusion machines are essential devices used in various manufacturing processes to shape materials by forcing them through a die.

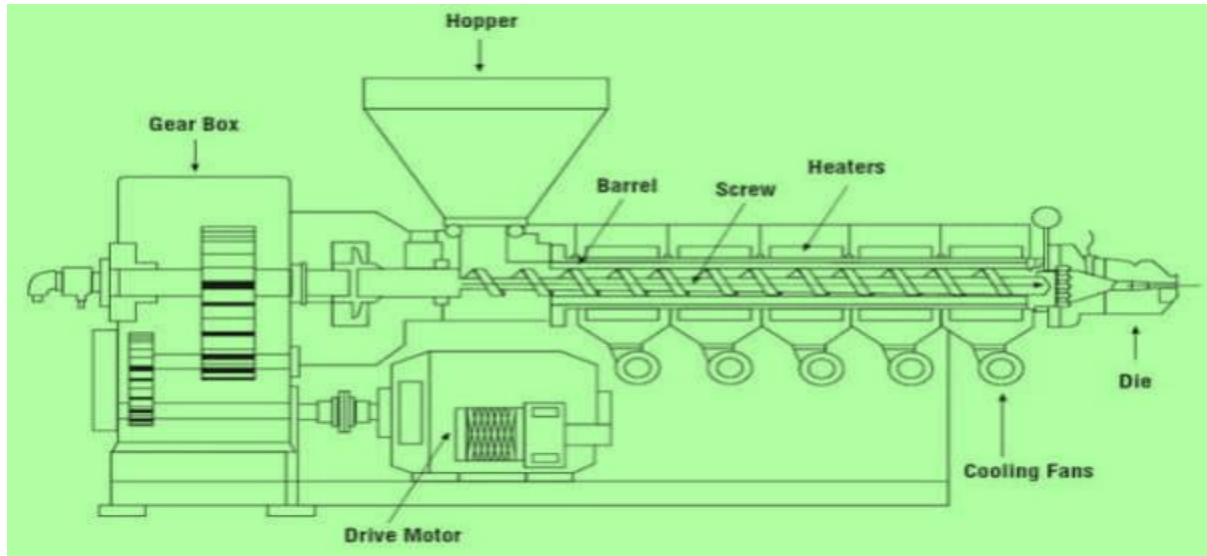


Figure 2.1 Structure of Extrusion Machine

2.4.1.1 Structure of Extrusion Machines

Extrusion machines consist of several key components that work together to facilitate the extrusion process:

1. **Hopper:** This is the initial reservoir where raw materials, typically in granular form, are fed into the machine.
2. **Barrel:** The barrel is a cylindrical chamber that houses the screw. It serves as the primary processing area where the material is heated, mixed, and compressed.

3. **Screw:** The screw is the core component of the extruder, responsible for conveying, compressing, and melting the material as it moves through the barrel. The design of the screw can vary, with single-screw and twin-screw configurations being the most common.
4. **Heating Elements:** Integrated into the barrel, these elements (such as electric heaters or steam jackets) raise the temperature of the material to the required levels for processing.
5. **Die:** Located at the end of the barrel, the die shapes the molten material into the desired profile as it exits the machine.
6. **Cooling System:** In some cases, a cooling system is included to rapidly cool and solidify the extruded product after it passes through the die.
7. **Control System:** This system manages the operation of the extruder, ensuring that parameters such as temperature and pressure are maintained for optimal performance.

2.4.1.2 Working Principle of Extrusion Machines

The working principle of an extrusion machine is based on the continuous transformation of raw materials into a finished product through several stages:

1. **Feeding:** Raw materials are introduced into the hopper, where they are gravity-fed into the barrel.
2. **Melting:** As the screw rotates, it pushes the material through the barrel. The combination of mechanical energy from the screw and heat from the heating elements melts the material, transforming it into a viscous flow.
3. **Mixing and Homogenization:** The design of the screw allows for thorough mixing of additives or colorants, ensuring a uniform material consistency.
4. **Extrusion:** Once the material reaches the appropriate temperature and viscosity, it is forced through the die. The shape of the die determines the cross-sectional profile of the final product.
5. **Cooling and Solidification:** After exiting the die, the extruded material is cooled, either through ambient air or a dedicated cooling system, allowing it to solidify into its final form.

2.4.1.3 Types of Extruders

- **Single-Screw Extruders:** These have one screw and are typically used for simpler extrusion processes, such as producing pipes and sheets.

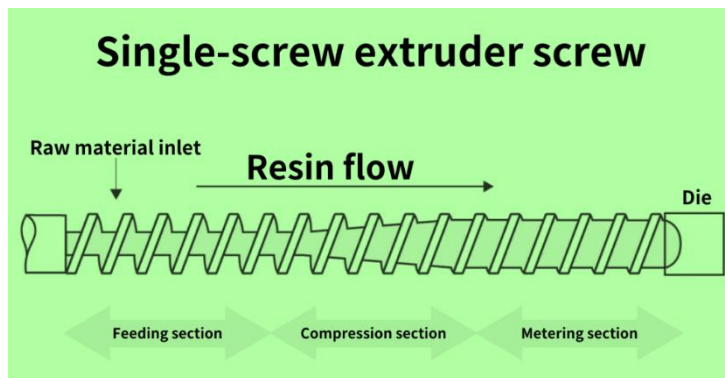


Figure 2.2 Diagram of Single Screw Extruder

- **Twin-Screw Extruders:** Featuring two intermeshing screws, these extruders provide enhanced mixing and are ideal for complex formulations, often used in food processing and the production of plastic alloys.

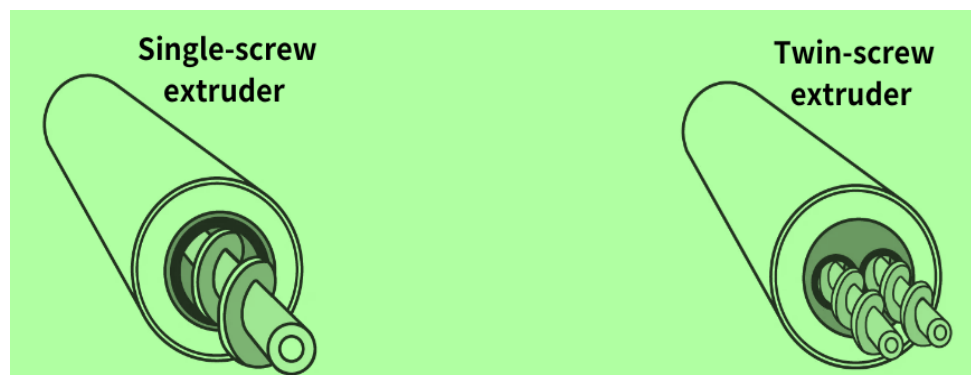


Figure 2.3 Single and Double Screw Extruder

- **Co-Extruders:** Designed to extrude multiple materials simultaneously, co-extruders create products with distinct layers or properties.
- **Specialized Extruders:** This category includes foam extruders, which produce foamed products, and others designed for specific applications.

2.4.1.4 Process Flow Diagram of Extrusion Machine

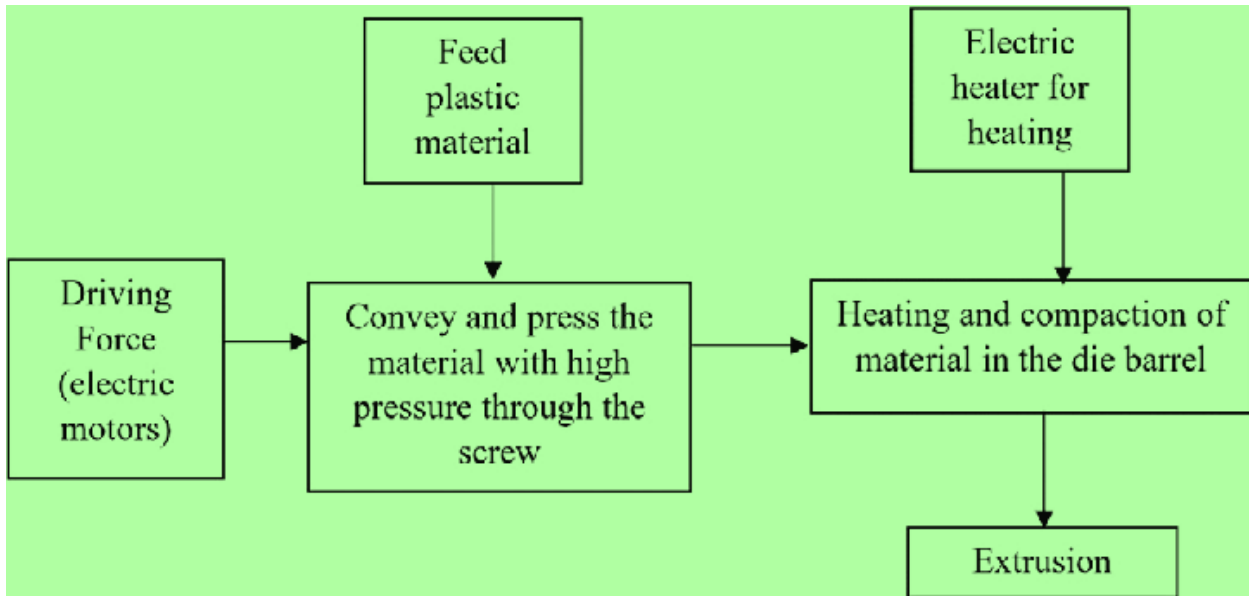


Figure 2.4 Processes Flow Diagram of Extrusion Machine

2.4.1.5 Applications of Extrusion Machines

Extrusion machines are widely used across various industries, including:

- **Plastic Manufacturing:** For producing pipes, sheets, and films.
- **Food Processing:** To create snacks, pasta, and other food products.
- **Pharmaceuticals:** For producing specific drug formulations.
- **Construction:** In the production of building materials like window frames and insulation.

2.4.2 Blow machines

Blow molding machines are essential equipment in the plastic manufacturing industry, used primarily for producing hollow plastic products such as bottles and containers

2.4.2.1 Structure of Blow Molding Machines

Blow molding machines consist of several key components that work together to shape plastic materials. The main structural elements include:

1. **Hopper:** This is where raw plastic materials (usually in pellet form) are loaded into the machine for processing.
2. **Extruder:** The extruder consists of a screw, barrel, and heating elements. It melts the plastic pellets and forms them into a parison, a hollow tube of molten plastic.

3. **Mold:** The mold consists of two halves that close around the parison. The shape of the mold determines the final shape of the product.
4. **Blowing System:** This includes a high-pressure air supply that inflates the parison inside the mold, allowing it to take the shape of the mold cavity.
5. **Cooling System:** After the parison is inflated and takes shape, it is cooled to solidify the plastic, ensuring it retains the desired form.
6. **Control System:** The control system manages the operation of the machine, including temperature control, pressure settings, and timing for each stage of the process.

2.4.2.2 Working Principle of Blow Molding Machines

The working principle of blow molding machines involves several sequential steps:

1. **Feeding:** Plastic pellets are fed from the hopper into the extruder.
2. **Melting:** The screw inside the extruder rotates, which generates heat through friction and external heating elements. This process melts the plastic pellets into a viscous state.
3. **Forming the Parison:** The molten plastic is extruded through a die to form a parison, which is a hollow tube with an open end.
4. **Mold Closure:** The mold closes around the parison, sealing it in place.
5. **Inflation:** Compressed air is blown into the parison through an air tube. This inflation causes the parison to expand and conform to the shape of the mold.
6. **Cooling:** The product is cooled within the mold to solidify the plastic. Depending on the machine's design, cooling can be achieved through air or water.
7. **Ejection:** Once cooled, the mold opens, and the finished product is ejected. Any excess material, known as flash, is trimmed away.

2.4.2.3 Key Considerations

- **Temperature Control:** Proper temperature management is critical at each stage to ensure optimal processing and product quality.
- **Pressure Settings:** The pressure of the compressed air during the blowing phase must be carefully controlled to achieve the desired product characteristics.

- **Material Properties:** The type of plastic used can significantly influence the blow molding process, affecting factors such as cooling time and blow pressure.

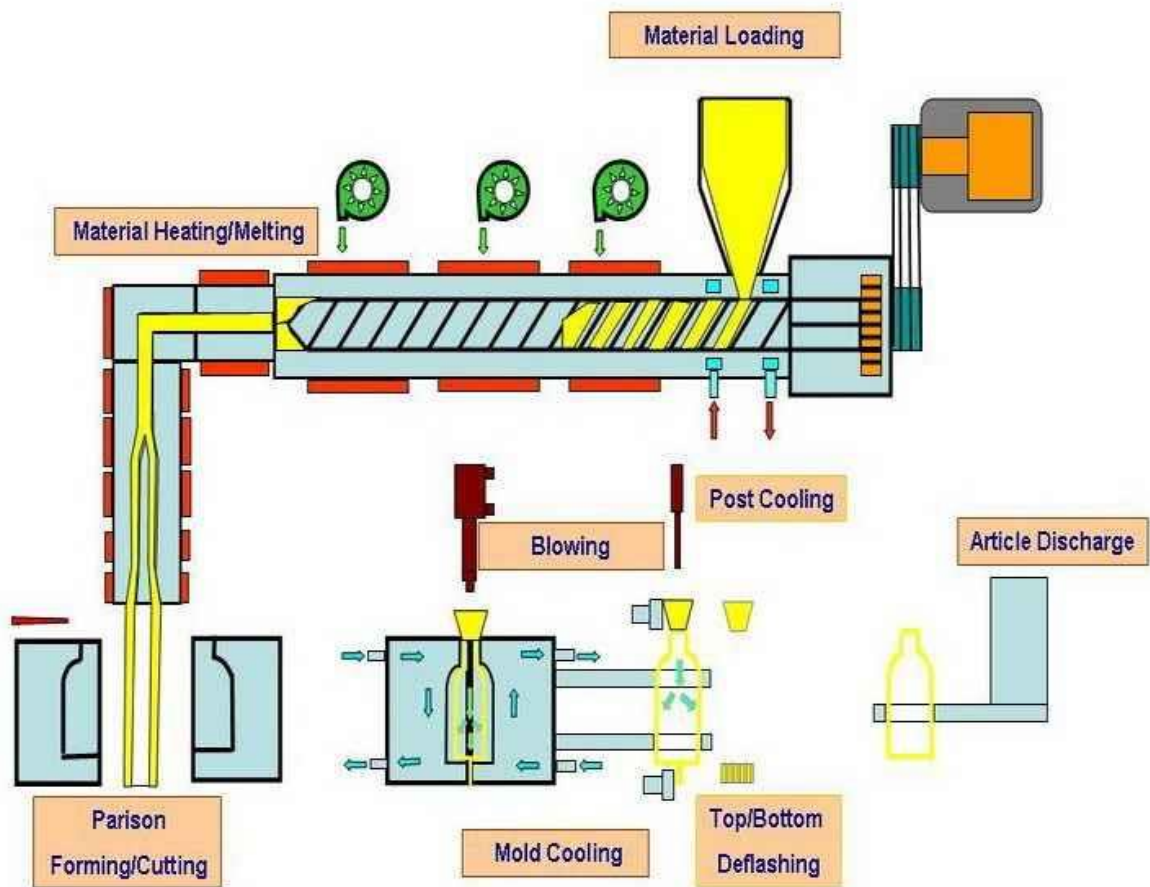


Figure 2.5 Process Flow Diagram of Blow Molding Machine

This process flow diagram and accompanying descriptions provide a comprehensive overview of the blow molding process, illustrating how raw materials are transformed into finished hollow plastic products efficiently

2.4.2.4 Applications of Blow Molding Machines

Blow molding machines are widely used in various industries, including:

- **Packaging:** For producing bottles, containers, and jars.
- **Automotive:** For manufacturing fuel tanks and other hollow components.
- **Consumer Goods:** For creating toys and household items.

2.4.3 Injection machines

The injection molding process is a manufacturing process used for producing parts or components by injecting molten material into the mold cavity. Injection molding can be performed with only one of these materials like glass, plastics, etc. and most commonly, thermoplastic polymers are used.

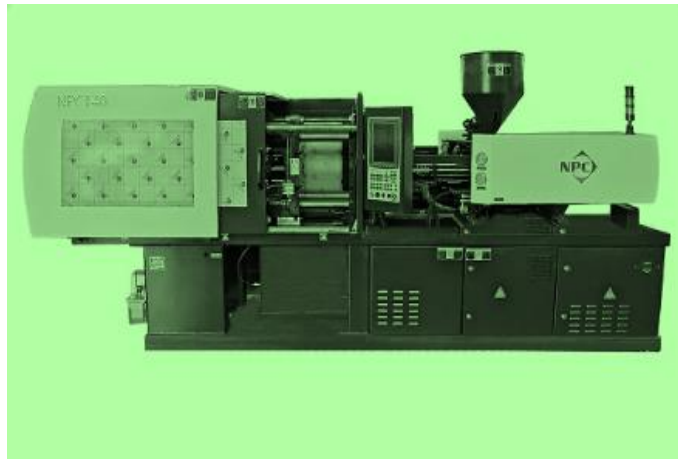


Figure 2.6 Injection Molding Machine

Working Principle of Injection Molding Machines:

1. Feeding: Plastic pellets are fed from the hopper into the barrel.
2. Melting: The screw rotates, generating heat through friction and external heaters, melting the plastic into a viscous state.
3. Injection: The molten plastic is injected into the closed mold cavity under high pressure through the nozzle.
4. Cooling: The plastic cools and solidifies within the mold.
5. Ejection: Once cooled, the mold opens, and the finished product is ejected.
6. Cycle Repeat: The machine resets for the next injection cycle.

2.4.3.1 Structure of Injection Molding Machines

1. **Hopper:** A container where raw plastic materials, typically in pellet form, are loaded.
2. **Injection Unit:** This includes:
 - **Screw/Plunger:** Melts and injects the plastic into the mold.

- **Barrel:** Heats the plastic and allows for its melting.
 - **Nozzle:** Directs the molten plastic into the mold.
3. **Clamping Unit:** Holds the mold in place during injection and opens it for ejection of the finished product. It includes:
- **Fixed Plate:** Where one-half of the mold is mounted.
 - **Moving Plate:** Where the other half of the mold is mounted, which moves to open and close the mold.
4. **Mold:** The two halves of the mold shape the plastic into the desired form.
5. **Hydraulic System:** Provides the necessary force for the injection and clamping processes.
6. **Control System:** Manages the machine's operations, including temperature, pressure, and timing.

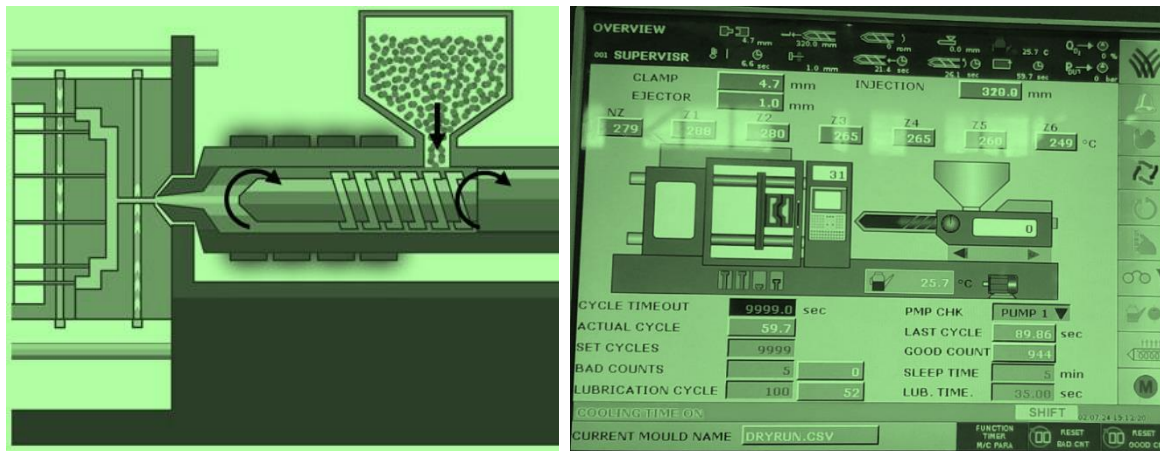


Figure 2.7 Process of Injection Molding Machine

Chapter Three

3 Background

Excel Plastics PLC, a prominent manufacturer of plastics in Ethiopia with over three decades of experience, has established a strong presence within the industry. However, the company faces operational challenges within its cutting processes, particularly due to reliance on an outdated manual limiting switch system for cutter activation. This manual approach leads to increased labor costs, reduced efficiency, and a higher potential for human error. The current method is time-consuming and hinders the company's ability to streamline operations, ultimately impacting productivity and profitability.

To address these challenges, this project focuses on developing an Automated Cutter Activation System Using Photoelectric Sensors, Timers, and Relays. This innovative system will utilize advanced photoelectric sensor technology to detect the presence of materials and initiate the cutting process, replacing the manual limiting switch with a more reliable and efficient solution. A timer will be integrated to control the duration of the cutting operation, ensuring precise control over the cutting process. Relays will manage the activation of the cutter based on inputs from the sensors and the timer.

Incorporating manual push buttons will provide operators with a reliable backup mechanism for manual activation or emergency stops, enhancing the overall safety of the operation. The integration of this automated system with a conveyor belt will facilitate the efficient movement of materials to the cutting area, further improving workflow.

The implementation of this automated cutter activation system is expected to significantly enhance the efficiency of the cutting process, reduce labor costs, and improve the accuracy and quality of cuts. By modernizing its cutting operations, Excel Plastics PLC can boost productivity, reduce waste, and maintain a competitive edge in the market, ultimately contributing to a more sustainable and efficient production process.

3.1 Project Overview

3.1.1 Business Problem

Excel Plastics PLC, a leading manufacturer in Ethiopia, is currently facing significant operational challenges due to its outdated manual cutter activation system. Key issues include:

- **Inefficiency:** The reliance on manual labor and limiting switches for the cutting process results in slower operations, leading to production delays.
- **High Labor Costs:** The manual activation method increases labor costs, as more personnel are required to operate the cutting machinery.
- **Error-Prone Processes:** The manual system is prone to human error, which can lead to inconsistent cutting quality and waste of materials.
- **Resource Allocation:** Ineffective resource utilization hampers the company's ability to maximize productivity and profitability.
- **Competitive Disadvantage:** The outdated system limits the company's ability to adapt to modern automation trends, putting it at a disadvantage compared to competitors who have embraced more efficient technologies.

3.1.2 Business Opportunity

The implementation of an automated cutter activation system using photoelectric sensors and relays presents a significant business opportunity for Excel Plastics PLC. Key benefits include:

- **Operational Efficiency:** Automation will streamline the cutting process, reducing cycle times and increasing throughput, leading to faster production rates.
- **Cost Reduction:** By minimizing reliance on manual labor, the company can lower labor costs, which can enhance overall profit margins.
- **Improved Accuracy:** The use of sensors will ensure precise cutting operations, reducing material waste and improving product quality.
- **Enhanced Resource Allocation:** Automation allows for better allocation of human resources, enabling staff to focus on higher-value tasks rather than repetitive manual operations.

- **Competitive Advantage:** Investing in modern technology positions Excel Plastics as a forward-thinking leader in the industry, attracting clients who prioritize efficiency and innovation.
- **Scalability:** The automated system can be easily scaled or integrated with other automated processes in the future, supporting long-term growth strategies.

By capitalizing on these opportunities, Excel Plastics can enhance its market position, improve profitability, and ensure sustained growth in an increasingly competitive landscape.

3.2 Objectives

3.2.1 General Objectives

To develop and implement an automated cutter activation system using photoelectric sensors and relays at Excel Plastics PLC, aimed at enhancing operational efficiency, reducing labor costs, and improving overall productivity in the cutting process.

3.2.2 Specific Objectives

- ❖ **System Design:** To design an automated cutter activation system that integrates photoelectric sensors and relays for precise condition detection.
- ❖ **Efficiency Improvement:** To reduce the cutting cycle time by at least 30% compared to the existing manual activation method.
- ❖ **Cost Analysis:** To analyze and quantify labor cost savings resulting from the implementation of the automated system.
- ❖ **Error Reduction:** To minimize human error in the cutting process, aiming for a 95% accuracy rate in cutting operations.
- ❖ **Prototype Development:** To develop a working prototype of the automated system and conduct performance testing to ensure reliability and effectiveness.
- ❖ **Training and Implementation:** To provide training for staff on the operation and maintenance of the new system to ensure smooth implementation and transition.
- ❖ **Sustainability Assessment:** To evaluate the environmental impact of the new system, focusing on waste reduction and resource optimization.

3.3 Problem and Solution

3.3.1 Problem

- **Inefficiency:** The manual activation process leads to slower production rates, causing delays in output.
- **High Labor Costs:** Dependence on manual labor increases operational costs, as more workers are needed for the cutting process.
- **Human Error:** Manual systems are prone to mistakes, resulting in inconsistent cutting quality and material wastage.
- **Resource Misallocation:** Ineffective use of workforce and machinery reduces overall productivity and profitability.
- **Limited Scalability:** The current system does not easily adapt to increasing production demands or integration with modern technologies.

3.3.2 Solution

- **Automated Cutter Activation System:** Implement a system using photoelectric sensors and relays to detect cutting conditions automatically, thus streamlining the process.
- **Efficiency Enhancement:** The automated system will reduce cutting cycle times by at least 30%, increasing overall production throughput.
- **Cost Reduction:** By minimizing reliance on manual labor, the company can significantly lower labor costs and improve profit margins.
- **Error Minimization:** Automation will enhance accuracy in cutting operations, targeting a 95% accuracy rate and reducing material waste.
- **Improved Resource Allocation:** With automation, employees can focus on higher-value tasks, optimizing the use of human resources and machinery.
- **Scalable System Design:** The automated system can be designed for easy scalability, allowing for future enhancements and adaptations to increasing production needs.
- **Training and Support:** Provide comprehensive staff training to ensure effective operation and maintenance of the new system, facilitating a smooth transition.



3.4 Proposal

3.4.1 Visions and Goals

3.4.1.1 Visions

To revolutionize the cutting operations at Excel Plastics PLC by implementing an advanced Automated Cutter Activation System that enhances efficiency, accuracy, and safety in the manufacturing process. This system will leverage cutting-edge technology, including photoelectric sensors, timers, and relays, to optimize production workflows and reduce operational costs, ultimately contributing to a more sustainable and competitive business model.

3.4.1.2 Goals

- **Increase Efficiency:** Implement an automated system that reduces downtime and accelerates the cutting process, leading to higher throughput and productivity.
- **Enhance Accuracy:** Utilize photoelectric sensors to ensure precise detection of materials, improving the quality of cuts and minimizing waste.
- **Improve Safety:** Incorporate manual push buttons for emergency stops and manual control, ensuring a safe working environment for operators.
- **Reduce Labor Costs:** Decrease reliance on manual labor for cutter activation, allowing personnel to focus on higher-value tasks and reducing overall labor expenses.
- **Streamline Operations:** Integrate the automated cutter system with existing conveyor infrastructure to create a seamless workflow, enhancing material handling and reducing operational bottlenecks.
- **Facilitate Maintenance and Troubleshooting:** Design the system for ease of maintenance, enabling quick identification and resolution of issues to minimize downtime.
- **Support Sustainability Initiatives:** By optimizing cutting processes and reducing waste, contribute to Excel Plastics PLC's commitment to sustainable manufacturing practices.
- **Achieve Competitive Advantage:** Position Excel Plastics PLC as a leader in the industry by adopting innovative technology that enhances operational capabilities and product quality.

By achieving these goals, the Automated Cutter Activation System will play a crucial role in enhancing the overall productivity and sustainability of Excel Plastics PLC's manufacturing operations.



3.5 Scope

1. System Design and Development: Design an automated cutter activation system that integrates photoelectric sensors, timers, and relays. Develop a user-friendly interface for manual control and monitoring.

2. Technology Integration: Implement photoelectric sensors for real-time detection of materials to trigger the cutting process.

- Utilize timers to control the duration of the cutting operation, enhancing precision and efficiency.
- Employ relays to manage the activation and deactivation of the cutting mechanism based on sensor inputs.

3. Installation and Configuration: Install the automated system within the existing cutting area of Excel Plastics PLC.

- Configure the system to work seamlessly with the current conveyor belt infrastructure to facilitate smooth material flow.

4. Testing and Validation: Conduct thorough testing of the system to ensure reliable operation, accuracy of cuts, and safety features.

- Validate the performance of the system against predefined metrics for efficiency, speed, and quality.

5. Training and Support: Provide training for operators and maintenance staff on the new system, ensuring they understand its operation and safety protocols.

- Develop support documentation, including user manuals and troubleshooting guides.

6. Performance Monitoring: Implement a framework for ongoing monitoring and evaluation of the system's performance post-installation.

- Collect data on efficiency improvements, cost savings, and quality enhancements to assess the impact of the automated system.

7. Future Expansion Considerations: Identify potential areas for future upgrades or expansions of the system, such as additional sensors or integration with other automated processes within the facility.

This project aims to enhance Excel Plastics PLC's cutting operations through automation, focusing on improving efficiency, accuracy, and safety while integrating seamlessly with existing processes.

3.6 Limitations

- **Initial Cost:** The upfront investment for the automated system, including sensors, relays, timers, and installation, may be substantial, potentially impacting short-term financial resources.
- **Complexity of Integration:** Integrating the new automated system with existing machinery and workflows may present technical challenges, requiring careful planning and execution to avoid disruptions.
- **Dependence on Technology:** The system's reliance on electronic components and sensors can lead to vulnerabilities. Failures in these components could halt operations and necessitate repairs or replacements.
- **Training Requirements:** Operators may require extensive training to effectively use and maintain the new system, which can consume time and resources during the transition period.
- **Maintenance Needs:** Regular maintenance and calibration of sensors and relays will be necessary to ensure consistent performance, which can incur additional costs and downtime.
- **Environmental Sensitivity:** Photoelectric sensors may be affected by environmental conditions such as dust, moisture, or temperature fluctuations, potentially impacting their reliability and accuracy.
- **Limitations in Material Types:** The system may have difficulty processing certain types of materials or colors that do not reflect light well, which could limit its overall effectiveness.
- **Resistance to Change:** Employees accustomed to manual processes may resist transitioning to an automated system, impacting morale and acceptance of the new technology.

- **Scalability Issues:** While the system is designed for current operational needs, scalability may be limited if future production demands exceed the system's designed capacity without additional upgrades.

By acknowledging these limitations, Excel Plastics PLC can develop strategies to mitigate potential challenges and ensure the successful implementation of the automated cutter activation system.

3.7 Literature Review

The integration of automation in cutting machines has gained significant attention in recent years due to its potential to enhance efficiency, safety, and productivity in manufacturing processes. The application of automation in cutting processes has transformed traditional manufacturing operations. According to the study by Gadale et al. (2015), the evolution from manual and semi-automated systems to fully automated systems has addressed several challenges, including reliability issues and production inefficiencies. Automated systems, particularly those utilizing Programmable Logic Controllers (PLCs), have demonstrated improved precision and faster execution times, enabling manufacturers to meet high-volume production demands while maintaining quality.

Programmable Logic Controllers are pivotal in modern automated systems, serving as the central control unit that manages inputs from various sensors and executes commands to control machinery. The literature indicates that PLCs enhance operational flexibility, allowing for adjustments in processing sequences to accommodate different product configurations (Gadale et al., 2015). This flexibility is crucial for cutting machines, where varying material types and sizes necessitate adaptable control strategies.

Photoelectric sensors play a critical role in detecting the presence and characteristics of materials before the cutting process. These sensors provide real-time feedback to the PLC, enabling precise control over the cutting operation. The ability to detect metal presence, as highlighted in the literature, contributes to safety by identifying faulty materials before they enter the cutting stage (Gadale et al., 2015). This proactive approach minimizes waste and reduces the risk of equipment damage.

Despite advancements in automation, manual controls remain essential for operational safety and flexibility. Push buttons serve as a backup mechanism, allowing operators to manually activate or



stop the cutting process when necessary. This dual-control approach ensures that operators can intervene in case of system failures or emergencies, enhancing the overall safety of the cutting operation.

The incorporation of pneumatic systems in cutting machines facilitates the movement and clamping of materials during the cutting process. Pneumatic actuators, when integrated with PLCs, provide precise control over the mechanical aspects of the operation. The literature underscores the efficiency gains achieved through pneumatic automation, which allows for faster cycle times and improved handling of materials (Gadale et al., 2015).

Safety is paramount in any cutting operation involving automated systems. The literature emphasizes the importance of implementing safety measures, such as emergency stop buttons and fault detection systems, to protect both equipment and personnel. The design of the automated cutter activation system must prioritize these safety features to comply with industry standards and ensure a secure working environment.

In conclusion, the integration of automation in cutting machines, supported by components such as PLCs, photoelectric sensors, manual push buttons, and pneumatic systems, presents significant opportunities for enhancing manufacturing processes. The insights gathered from the literature, particularly from Gadale et al. (2015), highlight the importance of these components in achieving operational efficiency, safety, and flexibility. As automation continues to evolve, further research and development will be essential to optimize these systems for varied industrial applications.

3.8 Materials

The following are some of the main materials required to build the automated sorting system of plastics by color.

3.8.1 Circuit breaker

They provide essential overcurrent and short-circuit protection, automatically interrupting electrical flow to prevent damage to sensitive equipment. With manual reset capabilities, breakers ensure that operators are alerted to issues before resuming operations, enhancing safety compliance. They also allow for the isolation of specific electrical circuits, facilitating maintenance without disrupting the entire system. Additionally, circuit breakers are easier to maintain compared to fuses and can be integrated with control systems for monitoring and alerts. Selecting the

3.8.2 Contactors

A detailed view of a Schneider LC1D thermal relay. The device is primarily black with a white front panel. It features three main terminals at the top labeled 1L, 3L, and 5L. The front panel has a green horizontal stripe with the 'Schneider' logo. Below the logo, there are three circular indicators labeled 13, NO, 21, and NC. At the bottom, there are three more circular indicators labeled 14, NO, 22, and NC. The device is mounted on a black base with mounting ears.

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3.8.3 Overload relay

Designed to protect motors and electrical circuits from damage due to excessive current. It continuously monitors the current flowing through the motor and trips the circuit when it detects a current level that exceeds the motor's rated capacity for a specified time. This automatic disconnection helps prevent overheating and potential damage to the motor and associated equipment. Overload relays often have adjustable trip settings, allowing customization for different motor ratings, and they may include visual or audible alarms to alert operators of a tripped condition. By incorporating overload relays, the system enhances safety and reliability, ensuring efficient cutting operations while safeguarding equipment from failure.



Figure 3.3 Overload relay

3.8.4 Delay timer

A delay timer is a critical component in the Automated Cutter Activation System, used to control the timing of operations for enhanced efficiency and safety. This device introduces a predetermined delay before activating or deactivating the cutting mechanism, allowing for smooth transitions between different stages of the cutting process. For instance, a delay timer can be programmed to wait for a brief period after the photoelectric sensors detect a material, ensuring that the system has stabilized before the cutter engages. This prevents abrupt starts and stops, reducing wear on the equipment and minimizing the risk of damage to the material being processed. Additionally, delay timers can facilitate safety by allowing operators to prepare for the operation, ensuring they are at a safe distance before the cutting begins. By incorporating a delay timer, the system improves operational reliability and enhances overall workflow efficiency.



Figure 3.4 Delay timer

3.8.5 Photoelectric Sensor

The system detects the presence or absence of materials using light. It operates by emitting a beam of light—typically infrared or visible light and monitoring the reflection or interruption of that beam. When an object enters the sensor's detection area, it either reflects the light to the sensor or blocks it, triggering a response.

There are several types of photoelectric sensors: through-beam sensors, which have separate emitter and receiver units; retro-reflective sensors, which use a reflector to bounce light back to the receiver; and diffuse reflection sensors, which detect objects based on the light reflected off them. These sensors are crucial for ensuring accurate detection of materials before the cutting process begins, facilitating precise automation, and enhancing safety by preventing accidental activation without material present. By providing real-time feedback to the control system, photoelectric sensors significantly improve the efficiency and quality of the cutting operation.



Figure 3.5 Photoelectric Sensor

3.8.6 Pushbuttons

Push buttons are vital manual controls in the Automated Cutter Activation System that allow operators to start, stop, and reset the cutting process. Their reliability and ease of use enhance safety and operational efficiency, making them an essential component of the system.



Figure 3.6 Push Buttons

3.8.7 Wiring Cables

wiring cables are vital for the functionality of the Automated Cutter Activation System, connecting power and signal components. Selecting the right type, gauge, and insulation is crucial for safety and efficiency, while proper installation ensures reliable operation and compliance with electrical standards.

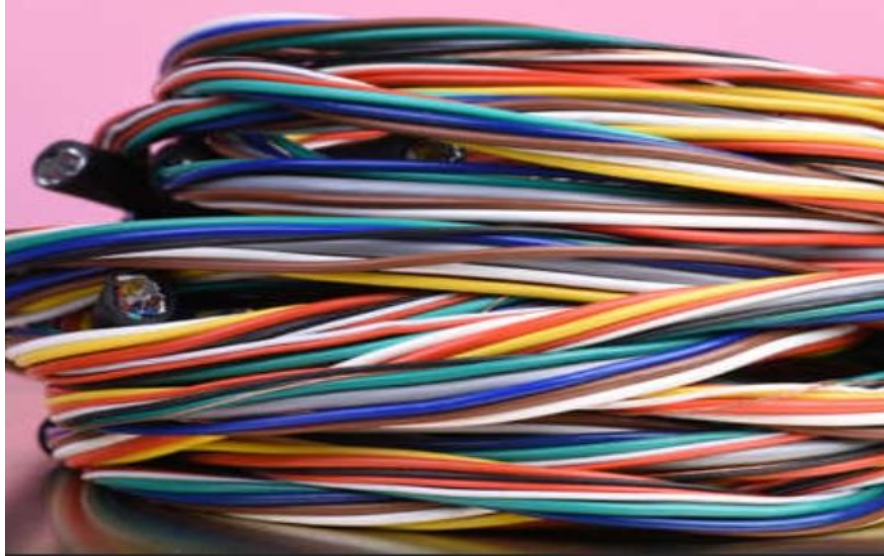


Figure 3.7 Wiring Cables

3.9 Methods Followed

The construction of the Automated Cutter Activation System involved a systematic approach to ensure effective design, implementation, and testing. The following methods were followed:

1. **Project Planning:** Defined project objectives, scope, and specifications.
 - Developed a timeline and budget, outlining key milestones and resource allocation.
2. **System Design:** Created detailed schematics for the electrical and control systems, including the layout of components such as photoelectric sensors, relays, timers, and push buttons.
 - Selected appropriate materials and components based on operational requirements and safety standards.
3. **Component Procurement:** Conducted a thorough review of all materials to confirm that they meet industry standards.
4. **Wiring and Assembly:** Installed wiring cables according to the schematics, ensuring proper connections between sensors, relays, timers, and the control panel.
 - Mounted all components securely, following best practices for electrical installations to avoid interference and ensure safety.
5. **Programming and Configuration:** Configured the delay timers and calibrated the photoelectric sensors for accurate detection and response.

6. **Testing and Validation:** Conducted thorough testing of the entire system to verify functionality, safety, and performance against predefined criteria.
 - Simulated various operational scenarios to identify any potential issues and make necessary adjustments.
7. **Training and Documentation:** Provided training sessions for operators on the new system, covering operation, safety protocols, and troubleshooting procedures.
8. **Implementation and Monitoring:** Implemented the system in the production environment, closely monitoring performance during the initial operation phase.
 - Gathered feedback and data to assess efficiency improvements and identify any areas for further optimization.

3.9.1 Engineering Specifications

1. System Components: Photoelectric Sensors:

- Type: Diffuse reflection
- Detection Range: Up to 2 meters (or as specified).
- Voltage Rating: 10-30 V DC.

2. Relays:

- Type: Electromechanical
- Contact Rating: Minimum 10 A at 250 V AC.
- Coil Voltage: 24 V DC.

3. Timers:

- Type: On-delay timers.
- Time Range: Adjustable from 1 to 10 seconds.
- Voltage Rating: 24 V DC compatible.

4. Push Buttons:

- Type: Momentary contact.
- Ratings: Minimum 10 A at 250 V AC.
- Features: Emergency stop or start button with a distinct color and marking.



5. Electrical Specifications:

- Voltage: 220 V AC (or as applicable).
- Frequency: 50/60 Hz.
- Circuit Breaker: Rated at 16 A for overcurrent protection.

6. Wiring:

- Cable Type: Multi-core, shielded for signal cables; heavy-duty for power cables.
- Gauge: Minimum 18 AWG for signal cables; minimum 12 AWG for power cables.

7. Performance Requirements:

- Response Time: Sensors must activate within 10 milliseconds of detecting an object.
- Cutting Accuracy: Tolerance of ± 1 mm for cutting operations.
- Operational Efficiency: The system should achieve a minimum of 90% uptime during operational hours.

8. Safety Standards:

- Incorporation of safety features such as emergency stop circuits and overload protection.

9. Testing and Validation:

- Functional testing to validate operation under specified conditions.
- Safety testing to ensure compliance with electrical and operational safety standards.

3.9.2 Engineering Targets

- The system must be able to be deployed within 4 weeks.
- The system must have a budget of no more than 200,000 ETB.
- The system must have a life span of at least three years.
- The system must be able to increase the efficiency of the manual system by 50 percent.
- Develop a user-friendly control panel with clearly labeled push buttons and indicators, ensuring operators can easily understand and operate the system.
- Design the system to operate with a maximum power consumption of less than 1 kW to enhance energy efficiency.



3.10 Development

3.10.1 Development Plan

3.10.1.1 Risks

- Technical challenges for deployment of the machine
- Difficulty in finding suitable materials
- Installation challenges of the system
- Unforeseen costs

3.10.2 Implementation

- 1) Design the system: Develop a detailed design of the system, including the following:
 - The placement of the sensor
 - overall control of the system.
 - Create a prototype of the system to test the design and identify any potential problems. This will help to ensure that the system is safe and reliable before it is deployed in production.
- 2) Install the sensor
- 3) Integrate the whole system

3.10.3 Testing

- a) Unit testing: I'm going to test the individual components of the system such as the sensor and all components to ensure they are working properly.
- b) Integration testing: I'm going to test the system to ensure that all components are working together properly.
- c) System testing: after that, I'm going to test the system in a production-like environment to ensure that it can handle the expected load.
- d) Performance testing: then after it passes the user acceptance testing, I'm going to conduct performance testing to ensure that the system can handle the expected load.

3.11 General Design of The Machine

The comprehensive design and control framework of an automated cutter activation system utilizing photoelectric sensors, relays, and pushbuttons that I developed.

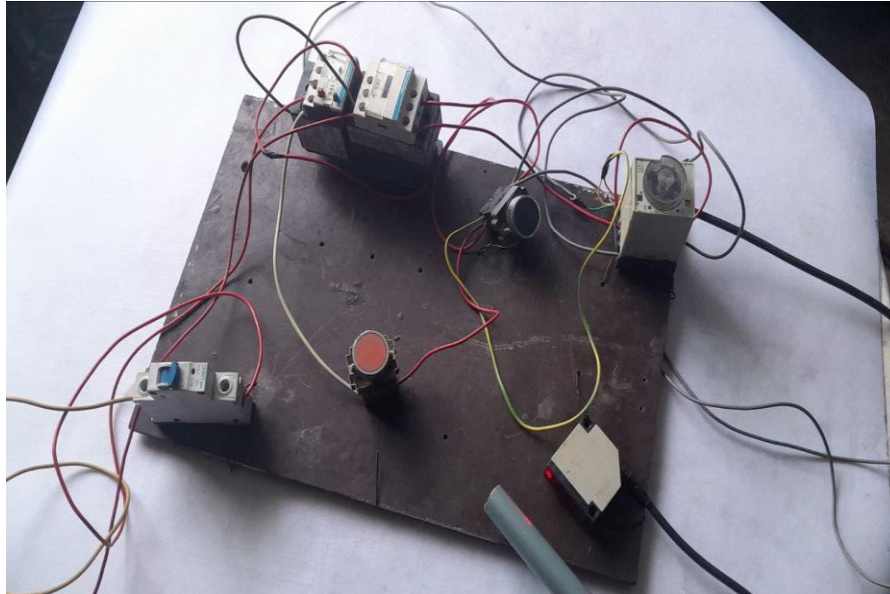


Figure 3.8 The New System Configuration Prototype



Figure 3.9 The Previous Manual Operating System Employed Limiting Switches

3.12 Working Principle of the System

The Automated Cutter Activation System operates through a coordinated interaction of various components, including photoelectric sensors, timers, relays, and manual push buttons. Here's a detailed breakdown of its working principle:

1. Material Detection: The system begins with photoelectric sensors that continuously monitor the presence of materials on the conveyor belt. Depending on the type of sensor (diffuse reflection), it either detects the reflection of emitted light or the interruption of a light beam.

2. Signal Processing: When the sensors detect a material, they send an output signal to the control unit. This signal indicates that the system is ready to initiate the cutting process.

3. Delay Timing: Upon receiving the signal from the sensors, the control unit activates a delay timer. This timer introduces a brief pause (e.g., 1 to 10 seconds), allowing the system to stabilize and ensuring that the material is correctly positioned for cutting.

4. Cutter Activation: After the delay, the control unit sends a command to a relay, which acts as a switch to activate the cutting mechanism. The relay engages the power supply to the cutter, enabling it to begin the cutting operation.

5. Manual Control: Operators can intervene using manual push buttons. A "Start" button initiates the cutting process, while an "Emergency Stop" button allows for immediate cessation of operations in case of a hazard. These buttons provide a safety net and manual override capability.

6. Cutting Process: The cutter operates based on the parameters set in the controlling unit. It performs the cutting action on the detected material, maintaining precision as dictated by the sensor feedback.

7. Post-Cutting Feedback: After the cutting process is complete, the system may reset automatically or require manual input from the operator to prepare for the next cycle. The sensors continue to monitor for the next material, looping back to the initial detection phase.

8. Safety Features: Throughout the operation, safety features such as overload relays and emergency stops ensure that the system can quickly respond to any irregularities, protecting both the equipment and operators.



3.12.1 Design Considerations

In the design of the system, the following variables must be taken into consideration.

1. System Layout:

- Compact Design: Optimize the layout to minimize space while ensuring easy access to components for maintenance.
- Flow of Materials: Design the system to facilitate smooth material flow from input to cutting and output, reducing bottlenecks.

2. Component Selection:

- Durability: Choose components (sensors, relays, timers) that can withstand the operational environment, including exposure to dust, moisture, and temperature variations.
- Compatibility: Ensure all components are compatible in terms of voltage, current ratings, and signal types to prevent failures.

3. Safety Features:

- Emergency Stops: Integrate easily accessible emergency stop buttons that immediately deactivate the system in case of a hazard.
- Overload Protection: Include overload relays to protect motors from damage due to excessive current.

4. User Interface:

- Intuitive Controls: Design a user-friendly control panel with clearly labeled push buttons and visual indicators to enhance operator interaction.
- Feedback Mechanisms: Implement visual or audible alarms to notify operators of system status changes or faults.

5. Electrical Design:

- Wiring Management: Plan for organized wiring to prevent interference and ensure ease of troubleshooting. Use appropriate cable types and gauges for power and signal lines.
- Power Supply Stability: Design the system to operate reliably under varying load conditions, ensuring stable power delivery.



6. Testing and Validation:

- Prototyping: Create prototypes to validate design choices and identify potential improvements before full-scale implementation.
- Performance Metrics: Establish clear metrics for testing system performance, safety, and efficiency.

7. Compliance and Standards:

- Regulatory Compliance: Ensure the design adheres to relevant industry standards and safety regulations (e.g., IEC, OSHA) for electrical and mechanical systems.

In summary, the design considerations for the Automated Cutter Activation System encompass system layout, component selection, safety features, user interface, electrical design, testing protocols, compliance with regulations, and environmental impact. Addressing these factors ensures the system operates effectively, safely, and sustainably.

3.13 Recommendations and Conclusions

3.13.1 Recommendations

This internship project lays a strong foundation for developing an automated cutter activation system utilizing photoelectric sensors and relays. However, several areas require further development and refinement to ensure the system's success and maximize its impact.

3.13.1.1 Recommendations for Future Work

1. Integration of Advanced Automation Technologies: Explore the incorporation of AI and machine learning algorithms to enhance predictive maintenance and optimize cutting parameters based on material properties and historical data.

2. Enhanced Data Analytics: Implement data analytics tools to analyze operational data from the cutting system. This can provide insights into performance trends, operational inefficiencies, and areas for improvement.

3. Remote Monitoring and Control: Develop a remote monitoring system that allows operators to oversee the automated cutter's performance from a centralized location, enabling quick responses to issues without being physically present.



4. Expansion of System Capabilities: Consider adding features such as automatic material feeding systems or multi-cutter configurations to increase throughput and flexibility in production.

5. User Interface Improvements: Design a more intuitive user interface for the control panel, incorporating touchscreens and graphical displays that can provide real-time data and alerts in a user-friendly format.

6. Feedback and Continuous Improvement: Establish a continuous improvement program that incorporates feedback from operators and maintenance staff to refine system performance and address emerging challenges.

7. Training Programs for Emerging Technologies: Develop training programs that focus on new technologies and methodologies related to automation, ensuring that staff remains skilled and informed about industry advancements.

3.13.2 Conclusions

The Automated Cutter Activation System represents a significant advancement in manufacturing efficiency and safety for Excel Plastics PLC. By integrating key components such as photoelectric sensors, relays, timers, and push buttons, the system streamlines the cutting process while minimizing human intervention and reducing the risk of errors.

Throughout the development and implementation phases, careful consideration of engineering specifications, safety standards, and user interface design has ensured that the system operates reliably and effectively. The incorporation of advanced automation technologies provides a solid foundation for future enhancements, such as data analytics and predictive maintenance, which can further optimize performance.

As the project progresses, focusing on areas of improvement—such as system efficiency, training, and safety protocols—will be essential for maximizing the benefits of the automated system. Continuous evaluation and adaptation to new technologies and methodologies will help Excel Plastics PLC maintain a competitive edge in the industry.

In summary, the successful deployment of the Automated Cutter Activation System not only enhances operational efficiency but also sets the stage for future innovations, ensuring a safer, more productive environment for all stakeholders involved.



Chapter Four

4 Overall Internship Experience Major Activities and Challenges

4.1 Theories to Practical Skills

As a university student, I spend most of my time acquiring theoretical knowledge. However, it is crucial to apply this knowledge practically in real-world situations. At Excel Plastic Company, I had the opportunity to operate and control advanced machinery. I also collaborated with technicians to perform preventive maintenance on these machines. This experience provided me with invaluable practical knowledge and skills. I learned that theoretical concepts can be effectively applied by gaining a deep understanding of how machines operate and their mechanisms. Additionally, I learned how to professionally identify the most likely causes of machine failures. Overall, the theories I learned in lectures were effectively realized during my internship experience.

4.2 Improving Team Playing Skill

Another important lesson I learned during my internship is that teamwork is essential for easily overcoming challenges. I realized that we are all interdependent on one another. Engineers must collaborate with others to achieve a common goal or complete a task in the most effective, swift, and efficient manner. A problem that initially appears very difficult to solve alone becomes a simple and enjoyable task when I come together with a group and begin to share ideas. When I work in a team, I feel more confident in performing tasks because I know I have colleagues around me who are willing to help and provide guidance.

4.3 Understanding Work Ethics-Related Issues

During my internship, I learned the importance of work ethics and how adhering to them helps accomplish tasks more efficiently and quickly. This also leads to positive interpersonal relationships in the workplace. I realized that knowledge alone is meaningless without the proper work ethic to put it into practice effectively.

The internship period taught me that respecting work ethics is crucial for success. When workers uphold ethical principles, it creates a smooth workflow and enables tasks to be completed faster



and more efficiently. Maintaining a strong work ethic also fosters kind and harmonious interpersonal relationships among colleagues.

4.4 Entrepreneurship skill

During my internship at Excel Plastic Company, I had the privilege of gaining valuable experience and developing my entrepreneurial skills. The key insights and lessons learned throughout my internship journey regarding:

- **Developing Entrepreneurial Skills:** My internship at Excel Plastic Company presented numerous opportunities to apply my skills and creativity to solve real-world problems. My challenges motivated me to think critically and approach situations with an entrepreneurial mindset. By leveraging my knowledge and problem-solving abilities, I was able to contribute positively to the company's operations.
- **Broadening Perspectives:** Before my internship, my understanding of the external working environment was limited. However, this experience allowed me to gain a more comprehensive perspective on the challenges and opportunities that exist in the real world. I was exposed to the complexities of the plastic industry and the competitive landscape, which helped me better comprehend the realities of the business world.
- **Recognizing Opportunities:** Through my internship, I developed a keen eye for identifying opportunities for growth and improvement. By observing the company's operations and analyzing industry trends, I was able to propose innovative solutions and strategies that could enhance efficiency and profitability. This experience has equipped me with the skills to recognize and capitalize on opportunities in my future endeavors.

4.5 Improving Interpersonal Communication

Effective interpersonal communication is vital for success in any organization. During my internship, I observed that enhancing communication skills among team members can significantly improve collaboration, productivity, and overall workplace morale. And also, I asked everyone whom I thought could share relevant information. By working with operators and technicians, I learned technical and professional terminology to communicate effectively with them in various work-related situations. As a result, I developed my interpersonal communication skills through my internship experience.



4.6 Major Activities I Have Done

During my internship at Excel Plastics PLC, I actively engaged in a variety of activities and responsibilities, gaining valuable experience and insights into the practical applications of my electromechanical engineering studies. The machines and the skilled workforce at the factory deeply inspired me, igniting a strong desire to fully understand their operations. This curiosity led me to undertake several interesting projects and tasks, which significantly contributed to my development as an engineer.

Early Weeks Foundation and Exploration In the first two weeks, I focused on comprehending the working principles and operations of the various machines within the company. I actively sought to explain these concepts to my company supervisor and clarify any uncertainties regarding machine operations. This process allowed me to acquire additional knowledge and insights.

Project Assignment: Room Temperature Controller In the following week, my supervisor assigned me a project to construct a room temperature controller using a contactor and a temperature regulator display, powered by a direct AC supply. I was tasked with drawing the power and control diagrams for the system. This project provided an excellent opportunity to expand my practical knowledge. I completed the assignment with the support of my colleagues, who provided technical assistance.

Troubleshooting and Maintenance Throughout the remaining weeks, I collaborated with technicians to troubleshoot and maintain machine malfunctions during operations. Some notable instances include:

- Extrusion Machine Heater Die 2-2 Malfunction:** During heating, the heater die 2-2 ceased functioning. Through analysis of the PLC controller and temperature readings, we identified the faulty contactor. We then systematically checked for grounding, measured the heater resistance, and examined the wiring. This process revealed a short circuit caused by a wire severed due to excessive temperature. The worn-out wire was replaced, restoring the heater's functionality.
- Screening Machine Ground Fault:** The screening machine experienced a ground fault, posing a safety hazard to the operator. These troubleshooting experiences honed my problem-solving skills and allowed me to apply engineering principles to practical situations. I developed abstract solutions for various issues, proposing innovative approaches to address them.

Overall Impact of My internship at Excel Plastics PLC provided invaluable practical experience, fostering my growth as an electromechanical engineer. The exposure to real-world challenges, the collaboration with skilled technicians, and the opportunity to apply theoretical knowledge to practical situations have significantly enhanced my problem-solving abilities and engineering expertise.



4.7 Challenges I Faced During Internship

I encountered several challenges during my internship:

1. **Unfamiliarity with Older Machines:** Many of the machines at Excel do not have clear display formats or operational guidelines, making it challenging for me to identify and address minor issues.
2. **Limited Access to Manuals:** The absence of accessible manuals for the machines hindered my ability to reference them, complicating my learning of their operations and maintenance procedures.
3. **Difficulty Accessing Internal Components:** Since the machines were already installed, it was challenging for me to understand their internal components and workings.



Chapter Five

5 Conclusion and Recommendation

5.1 Conclusion

In conclusion, my internship at Excel Plastics PLC has been an invaluable experience that significantly contributed to my professional and personal growth. The opportunity to engage with advanced machinery and collaborate with skilled technicians provided me with practical insights that bridged the gap between theoretical knowledge and real-world applications. Throughout my tenure, I faced various challenges that honed my problem-solving skills and deepened my understanding of electromechanical engineering principles, particularly in HMI operation and sensor integration within industrial machinery. The hands-on experience, especially in troubleshooting and maintaining complex systems, reinforced my ability to adapt and innovate in a dynamic work environment. This internship not only enhanced my technical competencies but also instilled a strong appreciation for teamwork and effective communication in achieving common goals. Overall, the skills and knowledge I gained during this period will undoubtedly serve as a solid foundation for my future endeavors in the engineering field.

5.2 Achievements

During my three-month internship at Excel Plastics PLC, I successfully applied classroom theory to real-world practice within the Technical Department, focusing primarily on the electrical section but also gaining experience in mechanical and operations. My responsibilities included working with and understanding the operation of various machines, including extrusion, blow molding, and injection molding machines, as well as supporting equipment such as laser cutters, welding machines, and various machining tools. I gained hands-on experience using Programmable Logic Controllers (PLCs) to control motors, pumps, and pneumatic/hydraulic systems based on sensor feedback and became proficient in using Human Machine Interfaces (HMIs) to interact with and control the machinery. Furthermore, I developed a comprehensive understanding of various sensor types, including proximity, temperature, water level, and pressure sensors, and how they contribute to the automated operation of the machinery. My work involved troubleshooting minor electrical issues and contributing to the overall efficiency of the production process. A significant



accomplishment was the design and implementation of an automated cutter activation system, improving safety and efficiency by integrating sensors to control the cutting process. This project directly addressed the need for enhanced automation within the factory, as highlighted in the company's ongoing efforts to modernize its production lines. Beyond technical skills, I significantly improved my interpersonal communication and teamwork abilities through collaboration with colleagues. The internship provided valuable insight into work ethics and fostered the development of entrepreneurial skills, enhancing my overall professional growth and preparedness for future employment. The experience solidified my understanding of the manufacturing process from raw materials to finished products, providing a strong foundation for my future career in electromechanical engineering.

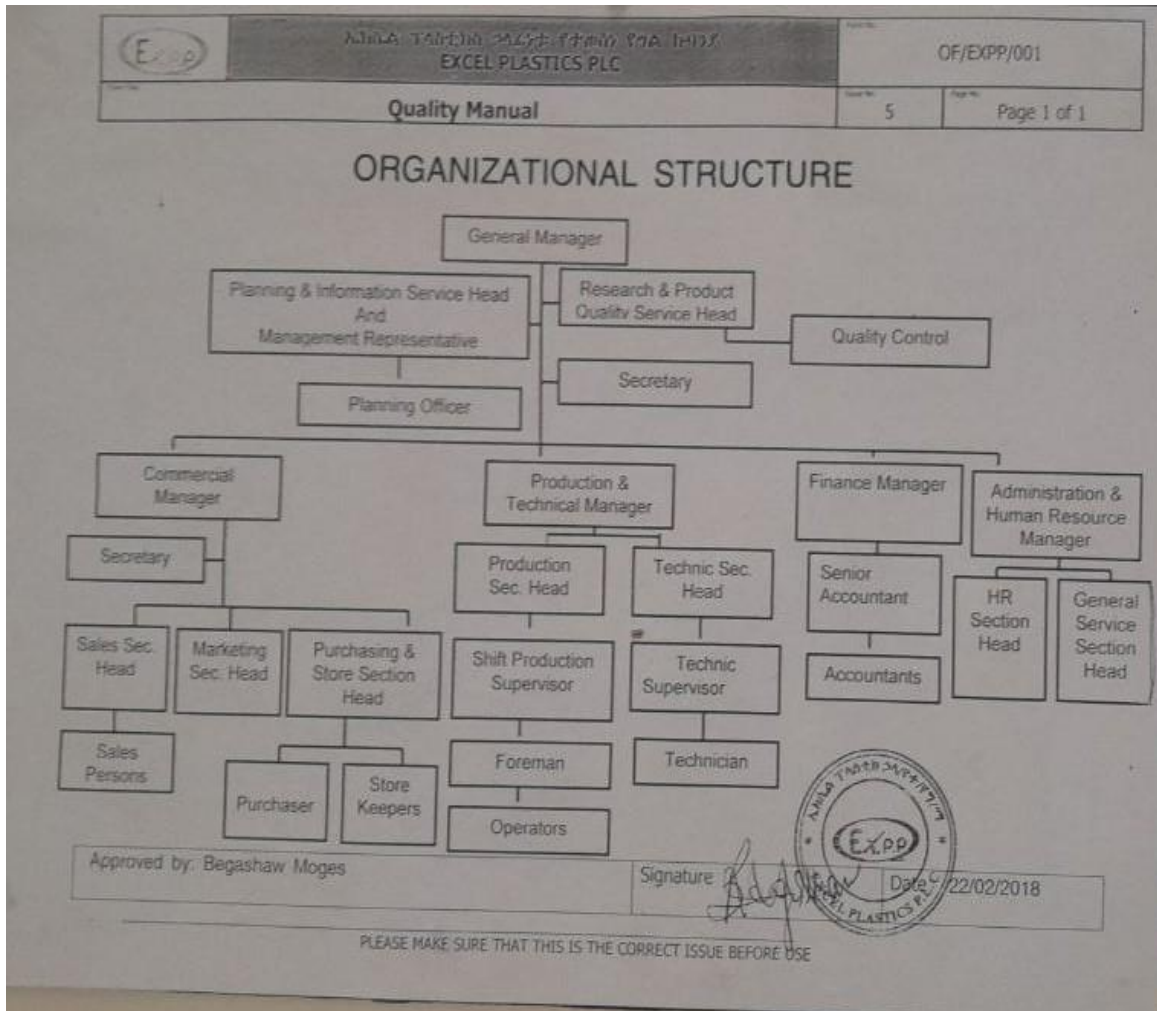
5.3 Recommendation

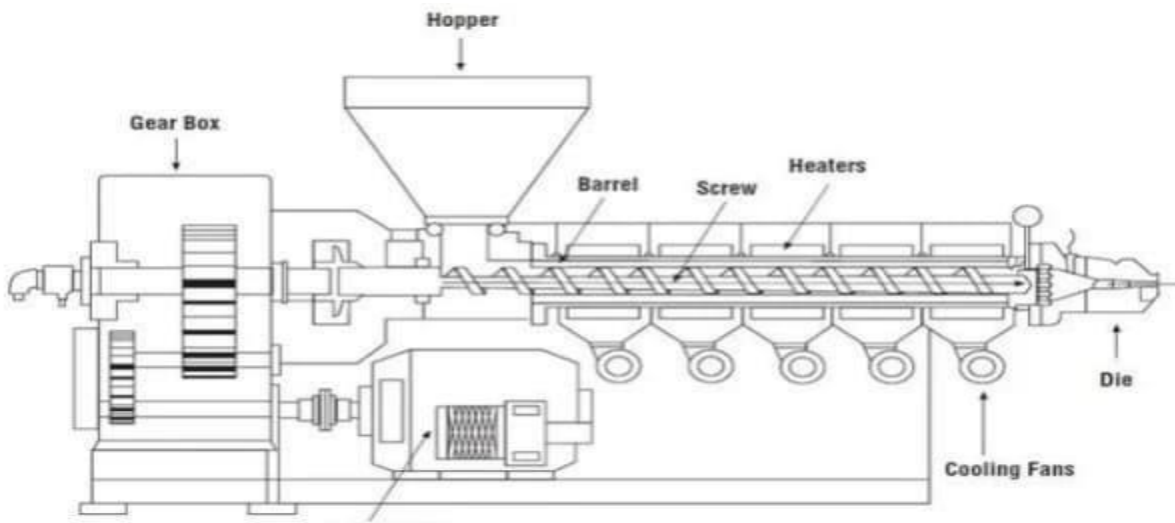
Based on my internship experience at Excel Plastics PLC, I highly recommend several key improvements to enhance operational efficiency and product quality. Firstly, investing in advanced sensor technology, such as high-precision pressure and temperature sensors integrated with a more sophisticated PLC system, would allow for real-time monitoring and automated adjustments to the extrusion, blow molding, and injection molding processes. This would minimize human error, reduce material waste, and ensure consistent product quality. Secondly, implementing a comprehensive preventative maintenance program for all machinery, including regular inspections, lubrication schedules, and timely part replacements, would significantly reduce downtime and extend the lifespan of the equipment. Thirdly, the company should explore the integration of Industry 4.0 technologies, such as data analytics and predictive maintenance software, to further optimize production processes and proactively identify potential issues before they impact production. Finally, investing in employee training programs focused on advanced machine operation, troubleshooting, and preventative maintenance techniques would empower the workforce to contribute more effectively to the company's overall success. These recommendations, if implemented, would position Excel Plastics PLC for sustained growth and enhanced competitiveness in the Ethiopian market.

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Appendixes





Single-screw extruder screw

