TR400 - INDUSTRIAL TRAINING

INDUSTRIAL TRAINING REPORTS

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E/19/128

MECHANICAL ENGINEERING

FACULTY OF ENGINEERING UNIVERSITY OF PERADENIYA SRI LANKA

INDUSTRIAL TRAINING REPORT I

TRAINING ORGANIZATION : ANSELL LANKA (PVT) LTD

PERIOD OF TRAINING : FROM 16.08.2023 TO 20.10.2023

FIELD OF SPECIALIZATION: MECHANICAL ENGINEERING

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ACKNOWLEDGEMENTS

I am incredibly grateful and content with the instruction I received at Ansell Lanka, Biyagama. Thus, in order to make this time a success, I would want to express my profound gratitude to everyone who helped me along the way, gave me motivation, and shared their invaluable knowledge and experience.

First of all, I want to express my gratitude to Professor Asanga Ratnaweera, the chairman of the mechanical engineering department, for mentoring us over the entire training program. His advice and knowledge were very beneficial to me in overcoming the obstacles I encountered during my training. In addition, I want to thank the National Apprentice and Industrial Training Authority and the University of Peradeniya's Industrial Training & Carrier Guidance Unit for giving me this chance.

Next, I would like to sincerely thank Mr. Sadakelum Edirimanna, my supervisor and the TNT plant engineer. I am also extremely appreciative of Mr. Chamila Wijerathna, the head of the HGBU department at Ansell Lanka, for providing me with this professional experience, direction, and inspiration during my time at Ansell.

Lastly, I would want to express my gratitude to all of the HGBU staff members, as well as all other workers, helpful staff, and colleagues I encountered during the training, who helped to make my training experience a wonderful professional experience.

K.T.S. Gunathunga

7th of July 2024

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LIST OF ABBREVIATIONS

HGBU	Healthcare Global Business Unit
HR	Human Resources
IGBU	Industrial Global Business Unit
PLC	Programmable Logic Controller
PPE	Personal Protective Equipment
PID	Proportional Integral Derivative
CAD	Computer Aided Design
MGBU	Medical Global Business Unit
SGBU	Single Use Global Business Unit
KPI	Key performance Index
LOTO	LockOut/TagOut

CHAPTER 1

INTRODUCTION

1.1 Training Session

I completed my industrial training term at Ansell Lanka Private Limited in Biyagama from 16.08.2023 to 20.10.2023 as a Mechanical Engineering undergraduate. I was assigned as a trainee to Department of Health care and Global Business unit. The National Apprentice and Industrial Training Authority and the University of Peradeniya's Industrial Training & Carrier Guidance Unit oversaw this training program.

1.2 Introduction To Ansell Lanka (Pvt) Ltd

One of the pioneers in protective solutions is Ansell Lanka (pvt) Ltd. Ansell has been providing the most cutting-edge safety solutions to millions of people for 125 years, whether they are at work, home, or anyplace else there are hazards. The company's creative products, market knowledge, and cutting-edge technology have given them a level of confidence and peace of mind that no other brand can match. They primarily supply industrial and surgical gloves to people worldwide. In addition, they offer global-manufactured protective apparel, goggles, face masks, and sleeves.

Figure 1.1 Ansell Logo

1.2.1 Vision

“We are innovators striving to create cutting-edge technologies and solutions that will allay workers' worries and provide a more secure and safe working environment. The ideal future is one in which individuals are as well-protected from environmental hazards as feasible. People should receive the right kind of protection depending on the situation, whether they are at work or not.’’

1.2.2 Mission

"To provide innovative solutions in a trustworthy and reliable manner creating an Ansell protected world"

1.2.3 Ansell Departments

Ansell Lanka has two main global business units.

- HGBU (Health care Global Business Unit)
- IGBU (Industrial Global Business Unit)

Furthermore, the HGBU is categorized into two basic units.

- MGBU (Medical Global Business Unit)
- SUGBU (Single Use Global Business Unit)

Also, Global Engineering and Manufacturing Technology Department

MGBU (Medical Global Business Unit)

Patients and healthcare professionals can choose from a unique range of preoperative safety solutions offered by Medical Global Business Unit. To reduce allergic reactions, staff injuries in clinical environments, and medical errors, a creative range of medical gloves and safety gear is offered. This facility produces surgical and medical gloves under several brand names. Ten dipping machines are included in this section; they are numbered 1, 2, 3A, 3B, 4, 5, 6, 7, 8, and 9. Some of the brands that are produced at this plant are listed below. You can get this glove beaded or unbeaded, powdered or powder-free.

SUGBU (Single Use Global Business Unit)

There are four TNT machines at this unit: machines 1, 2, and 3. You should only use these gloves once. Additionally, these gloves are chemical-resistant. They sell two primary items.

- Touch N Tough
- High Chem

IGBU (Industrial Global Business Unit)

The Industrial Global Business Unit produces and distributes high-performance, multipurpose protective products with a broad range of industrial uses, with a focus on hand, foot, and body protection. In every business, including automotive, chemical, metal fabrication, machinery and equipment, food, services and agriculture, construction, mining, janitorial/sanitation, military, first responders, and household goods, there is a significant difference in the products offered.

The Industrial Global Business Unit consists of four distinct plants. These are

- Plant A – Consider of machines 1,2,3,4 and 9 for glove dipping.
- Plant B – Consist of machines 5,6,7 and 8 for glove dipping.
- Plant C – Screen printing and Yarn covering.
- Plant D – Former mounting and Storage.

Figure 1.1 IGBU and HGBU Products

1.2.4 Organizational Structure

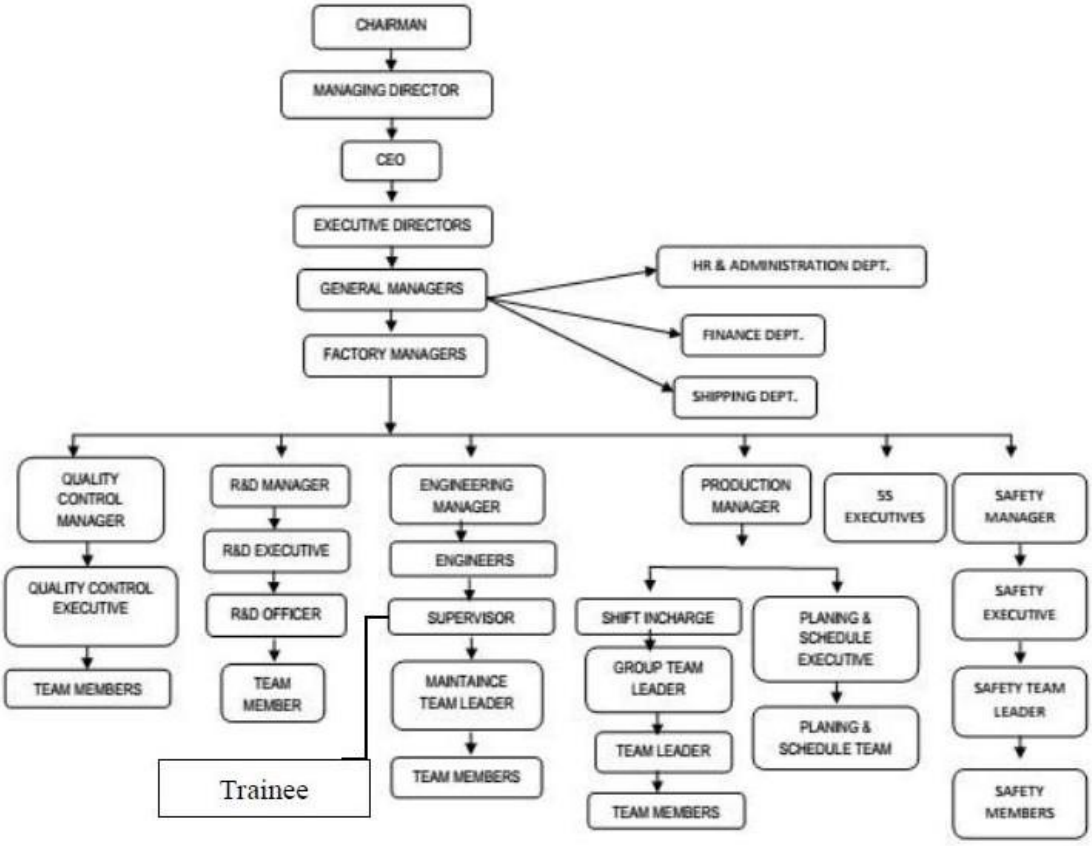


Figure 1.3 Organizational Structure

Organizational Structure and Production Management

Ansell Lanka operates with a well defined hierarchical organizational structure that ensures efficient coordination across departments. Each production unit such as HGBU and IGBU is overseen by line managers who are responsible for supervising daily operations, ensuring product quality, managing shift schedules, and meeting production targets. These line managers serve as critical links between top management and the factory floor, enabling smooth communication and effective implementation of policies. The structured workflow and delegation of responsibilities contribute to streamlined production processes and continuous improvement within the organization.

1.3 Summary Of The Work Engaged In Training

I was able to learn a great deal about industry during this training session as an undergraduate engineering student. Along with learning how to conduct myself in a professional setting, I also gained knowledge of glove production, industrial robotics, lean manufacturing, PLC and pneumatic systems, project management.

In my tenure as a intern in Ansell, I worked in the HGBU plant in TNT division and I learnt about the plant's production and overall scope of it. At first, I was introduced to the staff in the TNT section and was given a brief explanation on the process.

After the introduction I was assigned to draw drawings through SolidWorks and also conducted several other daily tasks and projects.

Also, in every week in my stay at Ansell I was able to conduct several OHS audits and conduct few meetings in health and safety to staff members.

CHAPTER 2

IN-PLANT EXPERIENCE

2.1 Introduction

IGBU and HGBU are Ansell Lanka's two main business units that manufacture gloves for export. Within the corporation, there are three plants—Plant A, Plant B, and Plant C—that house both business segments. The largest unit, unit A, has 13 HGBU production lines in total, along with additional HGBU processing and packaging facilities. In addition, Plant A has packaging facilities and IGBU production lines 1, 2, 3, 4, and 9. Production lines 5, 6, 7, 8, and 10 of IGBU are located at Plant B, along with packaging facilities. Finally, further IGBU processing and packaging facilities are located in Plant C. IGBU and HGBU use entirely distinct production methods.

During my training I was allocated as a trainee to the TNT plant under Department of Health Care and Global Business unit by HR unit. TNT plant is responsible for the production of 2 types of gloves which are single used. From the first day onwards, my supervisor gave me a brief explanation about the how the processes are done and how the work is carried by each team and members inside the TNT unit.

Also, a special safety introduction, rules and regulations were given to each newly appointed intern into the plant by Engineering Team supervisor and one member from the OHS department in Ansell Lanka.

Throughout my training I was assigned with various tasks and also daily work that needed to be conducted within the plant.

Also, within this time I was also involved with the team members for project management and team managements tasks and as well as weekly defect handling processes were also conducted for better outcome in the plant.

2.2 Healthcare & Global Business Unit (HGBU)

2.2.1 Introduction

Gloves used in the healthcare industry are produced at HGBU. HGBU is a well-regulated setting with extremely high standards of sanitation. Ansell manufactures medical gloves for use in surgery and diagnostic testing. They are well known throughout the world for providing dependable and superior medical gloves. Plant A in Ansell Lanka is home to all of HGBU's operations. Thirteen production lines,

multiple post-processing facilities, multiple packaging facilities, and a radiation sterilization facility are all part of HGBU's equipment.

The following are the main product categories that HGBU in Sri Lanka produces:

- **GAMMEX** - Neoprene, chemical accelerator-free surgical glove offering unsurpassed combination of sensitivity and durability. Gammex have several other sub categoriesas well. Latex, Non-Latex, PI Hybrid, Powdered and Powder-Free are those categories. These are sterilized with gamma radiation.
- **MICROFLEX** - Offers tactility and comfortable protection across numerous applications.
- **ENCORE** - Latex, powder-free surgical green under glove for effortless double gloving
- **TouchNTuff** - An unparalleled combination of chemical splash protection, comfort and durability

2.2.2 Manufacturing Process

Continuous production lines are employed by HGBU in their manufacturing process for every product. To mold the latex gloves on the production lines, ceramic formers are utilized. Ceramic formers are first cleaned of acids using hot water and then disinfected with acids again. To get ready for latex dipping, formers are dipped in coagulants or doping solutions and then dried in ovens. The glove is then formed by dipping formers into latex tanks. Depending on the substance, latex dipping may involve multiple steps. The glove is then partially cured by placing the formers in a latex gel oven. Subsequently, the formers pass through many coating tanks, alum or prime tanks, and leaching tanks to enhance the glove's current functionality and add additional elements. Following this, formers proceed via the primary Oven to completely dry the rubber. Next, slurry tanks are passed through by formers to facilitate glove handling. Ultimately, the gloves are removed by either completely automated or human labor techniques.

2.2.3 After-Processing

HGBU has a lot of after-processing activities because of its strict hygienic standards. These are HGBU's standard post-processing procedures. Gloves are first conditioned for a predetermined amount of time. After that, they are cleaned using water and hot water. They are then air dried before being chlorinated to

increase the glove's grip. They are then transferred to the siliconater. After using the last drier to dry them, they proceed to quality control and packaging.

2.2.4 Packaging

In order to uphold their quality standards, packaging is done in a very hygienic environment. Gloves are taken to the packaging section once they are freed from the after-processing area. Manual labor, somewhat automated, and completely automated procedures are used in packaging. They are then sent to the export warehouse.

2.2.5 Quality Control and Quality Assurance

Because HGBU has such strong standards for quality and dependability, it maintains exceptionally tight quality control and quality assurance. All production line's solution tanks are routinely checked, and quality control is strictly enforced in addition to collecting input from operators and maintenance personnel. Then, HGBU's quality assurance differs depending on the needs of the customer. All production is subjected to basic quality assurance using the acceptance sampling method. Samples are taken out of the production batch, examined visually, and put through a 1000 milliliter test. Gloves are evaluated for failure in a 1000 ml test by filling them with 1000 ml of pressured water.

2.3 Tnt Plant

During my training I was fortunate enough to learn about industrial standard glove making processes through the TNT plant. TNT plant has two production lines and each line were conducted in their own way of production for each product which was manufactured.

From the start of the machine line to the end there are different types of tanks, ovens, cleaning processes and also the after processes. All the processes are supervised by the engineering team and I was also participated on weekly checkups of the machines to ensure its efficiency and if it has any faults or not to be checked.

CHAPTER 03

PROJECTS AND CONTINUOUS LEARNING

3.1 Automated Chlorination System Project

3.1.1 Introduction

An automated chlorination system for the post-processing of glove manufacturing is designed to improve the quality and usability of latex gloves. Chlorination is a process that reduces the surface friction of gloves, making them easier to don and doff. This system typically involves exposing the gloves to a chlorinated solution, which reacts with the latex surface to achieve the desired properties. The automation of this process ensures consistent application, increased efficiency, and reduced labor costs. It also allows for precise control over chlorination levels, enhancing the durability and comfort of the gloves while ensuring compliance with safety and quality standards

3.1.2 My Contribution

As this is a newly introduced system for TNT plant, I was assigned to first to design the drawings for the system and how to connect it the chlorine tanks in the plant. The designs were done by using CAD software mainly SolidWorks. Using some given manuals and some other references I designed the main drawings for the system.

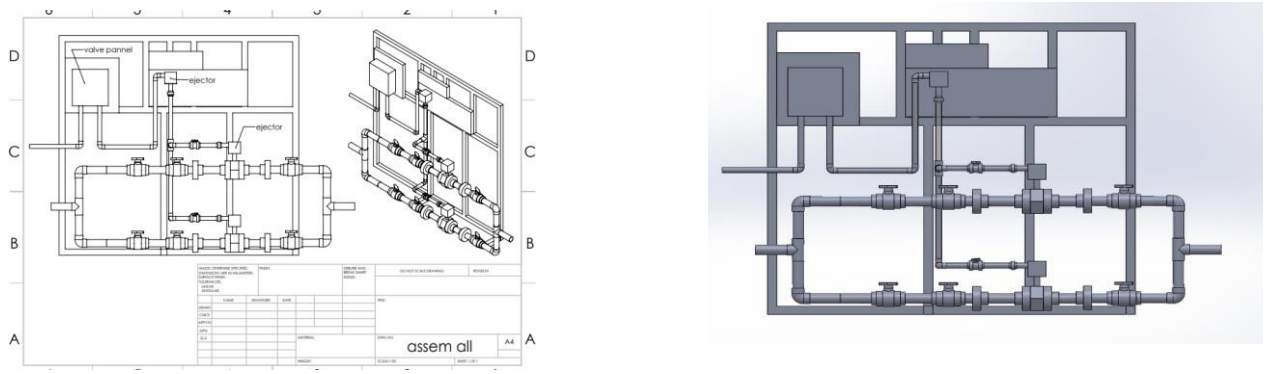


Figure 3.1 Design Drawings

In this project, I also created the BOQ for this projects needed components for the fabrication.

BILL OF QUANTITY - FUME LINE

Item No:	Description	Dimensions	Quantity	Unit Price	Amount
A	Manufacture & supply FRP Main Duct				
1	**FRP Ducts**				
1.1	D1000mm	Length = 78m			
1.2	D600mm	Length = 21m			
1.3	D300mm	Length = 55m			
2	**FRP Bends**				
2.1	D1000mm (90°)		4		
2.2	D1000mm (45°)		3		
2.3	D600mm (90°)		1		
2.4	D300mm (90°)		5		
3	**Reducer**				
3.1	1000mm x 600mm		1		
3.2	600mm x 300mm		2		
3.3	1000mmx300mm		1		
B	Post Leach 3/4 Canopy		2		
	Canopy Length	Length = 18m			
	Ridge	i.Length = 18m			
		ii.width= 0.3m			
		iii.height= 0.15m			
	Rafter	Length = 1m			
	Eaves Board	Height = 0.2m			
	Span	Span = 2.15m			
C	Hot Water Tank Canopy		2		
	Canopy Length	Length = 5m			
	Ridge	i.Length = 5m			

Figure 3.2 BOQ For Chlorine System

3.2 New Pre Brush-Unit Installation Project

3.2.1 Introduction

A pre-brush unit in glove manufacturing is essential for cleaning formers after gloves are removed and before they are dipped again. This unit ensures that any residual latex, powder, or contaminants are thoroughly cleaned from the formers. Effective cleaning of the formers is crucial to maintain high product quality, as it prevents defects and ensures a smooth surface for the next batch of gloves. The pre-brush unit also enhances production efficiency by reducing downtime for manual cleaning and contributes to consistent glove thickness and integrity.

3.2.2 My Contribution

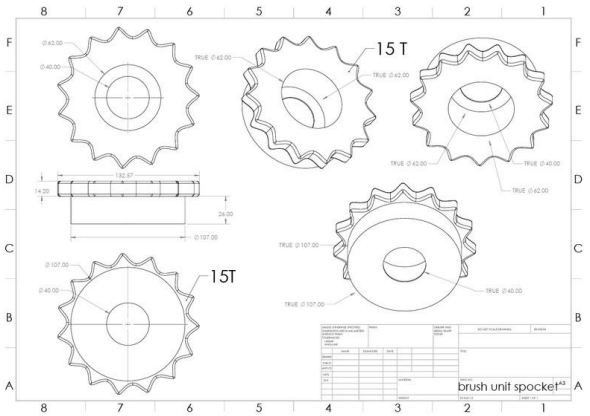
In the previous pre brush unit that was installed the formers which are sent to the brush unit had some residual latex parts were between in some areas of the formers. And after they are dipped some of the produced gloves had detects which resulting of the rejection that batch. There for me together with the technician team designed a brush unit with similar to the previous one with a different angle next to the previous brush unit.

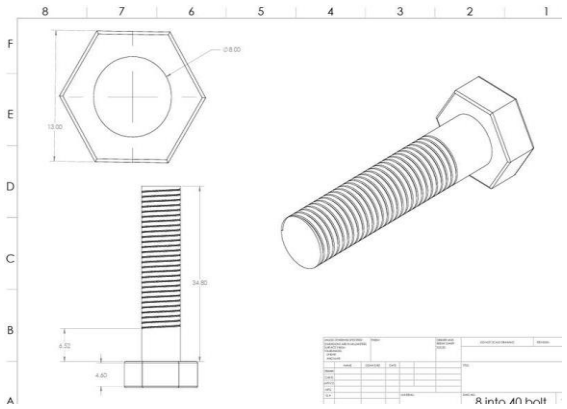
SolidWorks designing and planning for this brush unit was conducted in here. Also, after that the BOQ was created and requested the parts for the fabrication.

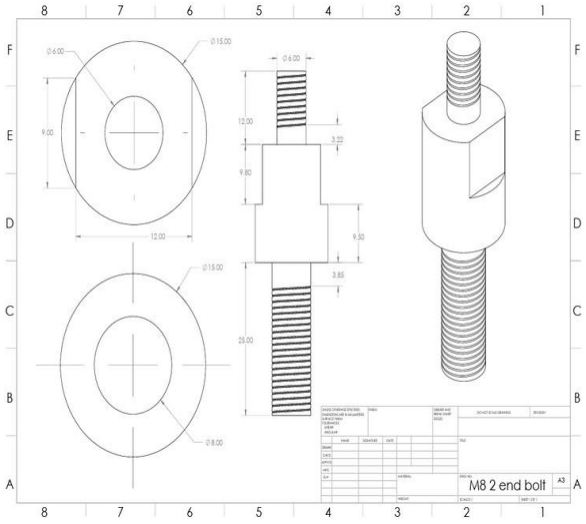
Figure 3.3 Previous Pre Brush-Unit

3.3 Other Contributions

I have been actively involved in designing various parts and machines for my plant, TNT, using SolidWorks. This hands-on experience has allowed me to apply theoretical knowledge to real-world applications, enhancing the efficiency and functionality of our equipment. My designs have focused on optimizing production processes, improving machine performance, and ensuring the reliability and safety of our operations. This practical work has not only strengthened my CAD skills but also provided valuable insights into the challenges and solutions in the engineering field.







3.4 Continuous Learning

3.4.1 Programmable Logic Controller (PLC)

PLC is an electrical device with a microprocessor. This apparatus manages a machine or a procedure. It is a compact yet potent computer that serves as a controller for industrial machinery. In order to operate a machine or process, sensors or control switches must be used to provide signals to a PLC. When sensors or controls provide input signals to a PLC, the PLC executes a previously created operator program that regulates actuators like motor controllers and solenoid valves, among others. Logic controls, counters, timers, closed-loop controllers, and arithmetic functions, among other functions, are built into PLCs. Programming a PLC usually requires familiarity with logic controls, timers, and math as PLC programmers are generally user-friendly and have built-in simulators that allow you to test your program before uploading it to a device.

There are several languages to program a PLC.

- Ladder Diagram.
- Function Block Diagram.
- Structured Text.
- Instruction List.
- Sequential Function Chart.

3.4.2 PID Controller

In industrial automation, a PID (Proportional-Integral-Derivative) controller is a frequently utilized feedback mechanism. It modifies an output according to the discrepancy between the current measurement and a desired set point. PID controllers regularly modify outputs in response to shifting conditions, which increases system accuracy and stability.

- The error value, or the difference between the intended set point and the actual measuring value, was continually calculated.
- This is appropriate for systems with low mass that respond rapidly to temperature control changes.

CHAPTER 4

INDUSTRIAL HEALTH AND SAFETY

4.1 Introduction

A sector's top priority is safety. For this reason, notifications indicating Safety First are visible everywhere. Accidents can happen to employees anywhere, at any time. I learned the fundamentals of environmental awareness and safety during the first week of my training while working at a factory.

For the sake of the employees' personal safety, the industry has a number of safety laws and guidelines.

- Wear the protective equipment.
- Prohibited unauthorized activities.
- Prohibited the cleaning the machine when the machine is running.
- Avoid the working of the ungraduated machine
- Avoid the use defective tools

4.2 Personal Protective Equipment

PPE is the first step to be safe in the industry. It must be worn whenever you entering to the working area. Without these, company do not take the responsible of any injuries we got. Ansell provides all kinds of safety equipment as much as possible. Each employee is given a safety hat, safety shoes, safety boots and couple of gloves. Each employee is provided with ear muffs as well.

- Safety shoes- Nobody is allowed to enter the plant without donning safety footwear. People can protect themselves from cutting, slipping, burning, falling objects, punchers, electrical, and chemical threats by using safety shoes.
- Goggles or safety glasses- It is mandatory for anybody working with chemicals or in areas where welding or grinding is taking place to wear safety glasses or goggles.
- Masks- within the plant, dust content is quite high. Specially around the glove stripping section, it is impossible to work without a mask. So, wearing mask is needy.
    - To protect from dust
    - To chemical retention

- Safety helmet- when a person walks through a construction area, it is compulsory to wear a helmet to protect head from falling objectives.
- Ear plugs – to protect ears from unbearable noises.
- Gloves
- Safety coats

4.3 Color Coding

To prevent accidents and misunderstandings Ansell has used color coding all over the site.

- Green - All the emergency exits and assembly points are coded in green.
- Red - Red shows prohibited areas and fire extinguishers.
- Yellow -Yellow shows all the hazard signs.
- Blue - Blue shows special guidelines which are native to special areas only.

4.4 Fire Safety

There is a working fire alarm system throughout the factory. The heat and smoke both affect this system. The fire alarms sound and an indicator light illuminates to help locate the precise location of the fire if there is one. A site map that is broken down into blocks is also available at the main administration office. The block will be shown in the system upon the activation of an alarm. Every employee receives training on how to handle such circumstances, and a factory fire drill is held twice a year for the chosen fire squad. Employees are taught to conduct the following when a fire alarm is heard:

- Stop Work
- Shut off machines
- Shut off gas & flames
- Put away valuable
- Keep evacuation route clear

4.5 LOTO Procedure

In industry and research contexts, lockout-tag out (LOTO), often known as lock and tag, is a safety process used to make sure that potentially dangerous devices are correctly shut off and cannot be started up again before maintenance or repair is finished. Before any work is done on the concerned equipment, hazardous energy sources must be "isolated and rendered inoperative". After that, the isolated power sources are locked, and the worker who locked them is identified by a tag attached to the lock. Next, the employee grasps the lock's key, guaranteeing that only they are able to turn on the machine. This prevents accidental startup of a machine while it is in a hazardous state or while a worker is in direct contact with it.

4.5.1 LOTO Devices

- Ball valve lockout
- Gate valve lockout
- Push button lockout
- Circuit breaker lockout
- Plug lockout
- Pad lockout
- Key Box
- Cables

CHAPTER 5

PRODUCTION & PROCESS IMPROVEMENT

5.1 Lean Procedure

The organization has recognized lean procedure as a key management procedure. They anticipate that these will raise the product's standards, boost output, and enable low-cost manufacturing. They also lessen the waste resulting from this. Lean manufacturing is a customer-focused methodology for systematic waste elimination and ongoing improvement. Lean manufacturing is different from conventional manufacturing in that it is process-oriented, whereas conventional manufacturing is people-oriented. It's a really good way to improve the company's Key Performance Indicators (KPI).

The degree to which waste is minimized directly affects the effectiveness of the lean Manufacturing methodology. The transportation and inventory sectors may be the source of the waste. It can also manifest as excessive production, idle waiting, needless movement, excessive processing, etc. The corporation has implemented just-in-time delivery and the pull system, which allow manufacturing to only occur when necessary, to help prevent such wastes. These methods also help to maintain constant inventory levels.

5.1.1 Wastes in Lean Manufacturing

There are 8 types of wastes in the lean manufacturing procedure.

- Over Production
- Waiting
- Unnecessary transportation
- Excess inventory
- Unnecessary motion
- Defects
- Over process
- Waste of unused talent and ingenuity

5.1.2 The 5S system

Another instrument that supports the lean manufacturing system is the 5s system. Five "s" represent five Japanese words that explain an approach to cut waste and boost productivity.

Seiri – Sort

Seiton - Set in order

Seiso - Shine (Clean)

Seiketsu –Standardize

Shitsuke– Sustain

It is decided in Seiri (sort) if a certain object is necessary, infrequently needed, or not needed at all. To do this, ask questions. Important sorting parameters include the object's purpose, how often it is used, and who utilizes it. When an object is determined to be useless, a yellow tag should be applied, and it should remain in the designated area for 30 days. This is in case another department finds use for the item. If no department finds use for it after 30 days, it is marked in red and transferred to the rubbish yard or possibly to be recycled. Seiton is the word for organizing. Items that have been sorted are arranged in order of significance. The most crucial things that are needed often are arranged in easily accessible locations.

Each of these things needs to go in the designated spot. Ansell organizes its inventory using shadow boards. Each object has a reserved spot that is highlighted with its name and an image, making it simple to reorganize the items after each use.

Seiso then refers to inspect and clean the work space. In this procedure, safety is also taken into account. Standards are written in Sheiketsu for the items that are ordered above. Health check papers and work sequence sheets are also used here. Shitsuke endures. It entails using the standards on a regular basis.

Cleaning charts and action plans for audit failures are used in this audit.

5.2 Ansell Production System

With a zero loss, zero defect, and zero waste mindset, Ansell Production is an organizational capability building strategy that aims to achieve and sustain breakthrough business results through 100% employee ownership.

Main Management Settings

- Center Lines
- Clean, Inspection, Lubrication
- Defect Handling
- Breakdown Elimination
- Initial Problem Solving

5.2.1 Defect Handling

In our defect handling process, every employee is responsible for identifying defects within the plant and marking the area with a defect tag. They must then record the defect in the log book. We categorize defects into seven main types: sources of contamination, unwanted parts, hard-to-access areas, unsafe conditions, quality defect sources, unfulfilled basic conditions, and minor flaws. These categories are represented on our loss tree, ensuring a systematic approach to addressing and rectifying issues.

The Defect tree updated only when defects are fixed. If the found defect were fixed by someone who has to update the defect log book with the date and the defect tag hang on the correct branch of the Defect tree

CHAPTER 6

SUMMARY AND CONCLUSION

6.1 Summary

The industrial training program at Ansell Lanka (Pvt) Ltd provided valuable exposure to real-world mechanical engineering practices in a high-standard manufacturing environment. Over the 10-week period, training encompassed core areas such as glove manufacturing processes, lean production methodologies, PLC-based automation, CAD-based equipment design, and industrial safety protocols. The hands-on experience in the TNT plant allowed direct involvement in system design projects like the automated chlorination system and pre-brush unit installation, as well as routine maintenance, team collaboration, and problem-solving tasks. Health and safety awareness was also a key aspect, reinforced by the implementation of PPE, color coding, and fire and LOTO procedures. This comprehensive exposure bridged the gap between academic knowledge and industrial application, preparing the trainee for future professional challenges.

6.2 Conclusion

The chance to work and train for ten weeks at Ansell Lanka at Biyagama has left me incredibly happy. Since this was my first experience with training, I was fortunate to work in a welcoming atmosphere where I had no trouble becoming trained. The organization that sponsored my successful 10-week training program supplied all of the facilities.

In addition to mechanical engineering, project management, and general industry expertise were among the things I was able to learn. I got the chance to learn about lean manufacturing, 5S, and other things, for instance. In addition, I got to examine various machinery, solve real-world issues, and put the theoretical information I learned in faculty to use. I had the opportunity to get knowledge on how to interact with workers of all stripes throughout the company in all departments. Dealing with many

personalities was an unusual experience that differed greatly from my undergraduate experiences. Even though we studied theory in college, applying it to real-world situations is a very different experience.

I thought I ought to get better at working in a team during the training. I was able to talk to my supervisor about any issues I ran across while working on the projects, and he was able to offer both technical advice and answers. The fact that this company allows for the option to undertake any type of research is another fantastic feature. They want to embrace our original and imaginative thoughts. Taking into account all the factors, receiving training prior to entering the field is crucial since it provides the necessary exposure and understanding of the field.

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INDUSTRIAL TRAINING REPORT II

TRAINING ORGANIZATION : SLT DIGITAL LABS

PERIOD OF TRAINING : FROM 29.07.2024 TO 11.10.2024

FIELD OF SPECIALIZATION : MECHANICAL ENGINEERING

K.T.S. GUNATHUNGA

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ACKNOWLEDGEMENT

I am incredibly grateful to the training I received at **SLT Digital Labs, Colombo 01**. Thus, in order to make this time a success, I would want to express my profound gratitude to everyone who helped me along the way, gave me motivation, and shared their invaluable knowledge and experience.

First of all, I would like to express my sincere gratitude to my supervisor, **Mr. Anil Pradeep Kumara**, Manager at **SLT Digital Labs**, whose invaluable guidance, continuous support, and insightful feedback significantly contributed to the successful completion of my industrial training. His mentorship enabled me to deepen my knowledge and improve my practical skills throughout this training period.

I am especially thankful to my team leader and team members at **SLT Digital Labs**, whose cooperation, assistance, and sharing of technical expertise created a productive and enjoyable working environment. Their friendly and supportive approach helped me immensely in overcoming challenges and gaining valuable professional experience.

Moreover, I extend my appreciation to the entire staff at **SLT Digital Labs** for their kindness, encouragement, and readiness to assist whenever needed. Their collective support enriched my experience and facilitated my integration into a professional setting.

Finally, I thank my university and academic staff for providing me with the opportunity to participate in this industrial training, enhancing my practical knowledge and preparing me for future professional endeavors.

K.T.S Gunathunga

19.04.2025

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LIST OF ABBREVIATIONS

SLT	Sri Lanka Telecom
AI	Artificial Intelligence
GPS	Global Positioning System
EKB	Enterprise Knowledge Base
PPE	Personal Protective Equipment
IDE	Integrated Development Environment
CAD	Computer Aided Design
PID	Proportional-Integral-Derivative
LLM	Large Language Model
FAISS	Facebook AI Similarity Search
API	Application Programming Interface
VPN	Virtual Private Network
IP	Ingress Protection

CHAPTER 1

INTRODUCTION

1.1 Training Session

I completed my industrial training at SLT Digital Labs (Pvt) Ltd, located in Colombo, from 29th July 2024 to 11th October 2024, as part of my undergraduate studies in Mechanical Engineering. I was assigned to the Research and Development (R&D) section at the SLT Head Office, Colombo 01. This training program was conducted under the supervision of the National Apprentice and Industrial Training Authority (NAITA) and the Industrial Training and Career Guidance Unit of the University of Peradeniya.

1.2 Introduction to SLT and SLT Digital Labs

Sri Lanka Telecom MOBITEL (SLT)

Sri Lanka Telecom (SLT) is the national telecommunications provider in Sri Lanka, offering a wide range of ICT (Information and Communication Technology) and broadband services across the country. Established as a state-owned entity and later transformed into a public company, SLT has played a vital role in shaping Sri Lanka's digital infrastructure. The company delivers services such as fixed-line telephony, high-speed broadband internet, IPTV, and data hosting to both individual consumers and large-scale enterprises. With its widespread fiber-optic network and focus on innovation, SLT continues to be a cornerstone in the country's journey towards digital transformation.

SLT Digital Labs (Pvt) Ltd

SLT Digital Labs (Pvt) Ltd is a fully owned subsidiary of SLT-MOBITEL and operates as the innovation and digital solutions arm of the SLT Group. Established to drive digital transformation initiatives within the group and for external clients, SLT Digital Labs specializes in areas such as software development, enterprise application solutions, AI and machine learning

applications, cloud services, digital infrastructure optimization, innovative solution designs and more.

As a center for research and development (R&D), the company fosters an environment where engineers, developers, and interns collaboratively engage in developing cutting-edge technologies tailored to real-world telecom and enterprise challenges. It also plays a key role in supporting national digital infrastructure and smart technology adoption. The innovation-driven culture at SLT Digital Labs makes it an ideal training ground for engineering undergraduates who seek exposure to industry-standard tools, methodologies, and emerging technologies.

Figure 1.1 SLT-MOBITEL Logo

1.2.1 Vision

“We are innovators striving to create cutting-edge technologies and solutions that will allay workers' worries and provide a more secure and safe working environment. The ideal future is one in which individuals are as well-protected from environmental hazards as feasible. People should receive the right kind of protection depending on the situation, whether they are at work or not.’’

1.2.2 Mission

"Your trusted and proven partner for innovative and exciting communication experiences delivered with passion, quality and commitment."

1.3 Overview of SLT Departments

- **Fixed ICT Operations**
  This department manages SLT's fixed-line services, encompassing voice communication, broadband internet, IPTV, and enterprise networking solutions. Utilizing technologies like optical fiber, ADSL2+, and VDSL2, it serves residential, business, and government clients across Sri Lanka.

- **Mobile ICT Operations – SLT-MOBITEL**
  Operating under the SLT Group, SLT-MOBITEL offers mobile services, including voice, data, and broadband. It has pioneered advancements such as 4.5G LTE and 5G trials, providing nationwide coverage and international roaming through partnerships with over 750 global networks.

- **Cloud and Hosting Services**
  This division provides cloud computing solutions, data center services, and managed hosting, catering to businesses seeking scalable and secure digital infrastructure.

- **IPTV and Content Services**
  SLT's IPTV services deliver digital television content, including live channels and on-demand programming, enhancing the entertainment experience for subscribers.

- **Human Resources and Training**
  Focused on talent development, this department oversees recruitment, employee training, and professional development programs to ensure a skilled workforce.

- **Research and Development – SLT Digital Labs**

  SLT Digital Labs serves as the innovation hub, driving research and development initiatives. It focuses on areas like software development, AI, machine learning, and digital transformation projects, fostering a culture of innovation and collaboration.

1.4 Organizational Structure

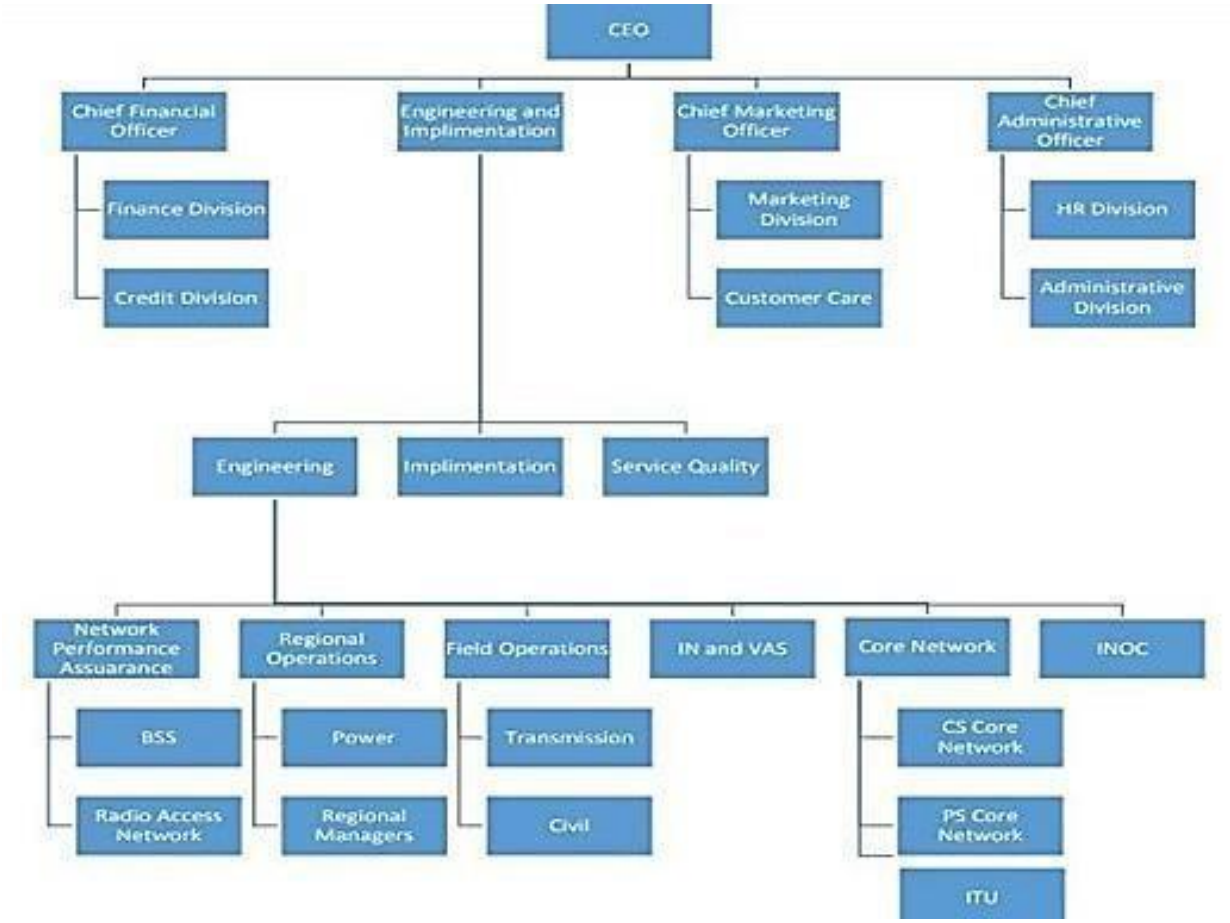

Figure 1.2: Organizational structure of SLTMobitel

SLT-MOBITEL Organizational Structure (Up to Intern Level)

SLT-MOBITEL operates under a **matrix organizational structure**, combining functional and project-based hierarchies. This structure facilitates efficient communication and collaboration across various departments and projects.

1) **Board of Directors**

- **Chairman**
- **Non-Executive Directors**

The Board provides strategic direction and governance for the organization.

2) **Executive Leadership**

- **Group Chief Executive Officer (CEO)**
- **Chief Operating Officers (COOs) for Fixed and Mobile Operations**

The executive leadership team oversees the overall operations and ensures alignment with the company's strategic goals.

3) **Senior Management**

- **Chief Officers and General Managers** for key departments:
    - **Technology**
    - **Finance**
    - **Marketing**
    - **Human Resources**
    - **Customer Experience**
    - **Digital Services**

Senior management is responsible for the strategic and operational management of their respective departments.

4) **Departmental Divisions**

Each department comprises several divisions led by **Senior Managers** or **Division Heads**, such as:

- **Network Operations**
- **Product Development**
- **Customer Support**
- **Research & Development (R&D)**
- **Information Technology (IT)**
- **Sales & Marketing**

These divisions handle the day-to-day functions and projects within their specific areas.

5) **Team Leads and Supervisors**

Within each division, teams are managed by **Team Leads** or **Supervisors** who oversee specific projects or operational tasks.

6) **Staff and Associates**

- **Engineers**
- **Analysts**
- **Technicians**
- **Administrative Staff**

These individuals execute the core functions and contribute to various projects and services.

7) Interns and Trainees

- **Undergraduate Interns** (e.g., Engineering, IT, Business)
- **Vocational Trainees**

Interns are typically assigned to specific teams or projects, working under the guidance of supervisors or mentors. They gain practical experience and contribute to ongoing initiatives within the organization.

1.5 Summary of the work engaged in the training

I was able to learn a great deal about industry during this training session as an undergraduate engineering student. Along with learning how to conduct myself in a professional setting, I also gained knowledge of several engineering applications.

During my training period at SLT Digital Labs, I had the opportunity to contribute to several hands-on and innovative projects. One of the major assignments was the **Automated Antenna Alignment System**, where I worked on designing and implementing a motorized mechanism to align telecom antennas based on signal strength and GPS data. Additionally, I was involved in the **mechanical design of a custom metal enclosure** for sensitive electronic components, ensuring both functionality and durability for outdoor conditions. I also gained valuable exposure to the **Enterprise Knowledge Base (EKB) system powered by AI**, where I learned how generative AI models are used to enhance document retrieval and knowledge management across the organization. These projects not only improved my technical skills but also gave me real-world experience in applying various engineering applications in a professional telecom environment.

Also, in every week in my stay at SLT Digital Labs I was able to participate on several webinars and programs to improve my knowledge as well.

CHAPTER 2

IN-PLANT EXPERIENCE

2.1 Introduction

Sri Lanka Telecom (SLT) is the nation's premier telecommunications service provider, offering a range of fixed and mobile communication solutions across the country through its flagship brand, SLT-MOBITEL. As a key technology enabler, the organization operates across various departments including Network Operations, Product Development, Customer Experience, Engineering, and Research & Development (R&D), among others.

I was placed at SLT Digital Labs, the innovation and research subsidiary of SLT, where I was assigned to the Research and Development (R&D) division located at the SLT Head Office in Colombo 01. SLT Digital Labs functions as the company's core driver for AI solutions, smart systems integration, and enterprise automation, contributing significantly to the digital transformation of the SLT Group and its services.

My role as an engineering intern allowed me to work closely with the R&D engineers on various technology-driven projects. These included the Automated Antenna Alignment System, where I contributed to designing and testing a prototype that optimizes antenna orientation using sensor data and GPS signals. I was also tasked with the mechanical design of a protective metal enclosure for sensitive telecom equipment, ensuring both structural durability and weather resistance. Furthermore, I had the opportunity to gain exposure to SLT's Enterprise Knowledge Base (EKB) project, a generative AI-powered system that intelligently organizes and retrieves internal organizational knowledge and documents.

A formal safety briefing, system overview, and organizational orientation were conducted during my first week, outlining the roles, responsibilities, and ethical guidelines for all interns and engineers working in SLT Digital Labs. Throughout my internship, I collaborated with senior engineers, project leads, and fellow interns in project reviews,

prototyping, debugging sessions, and technical presentations. This immersive exposure provided a clear understanding of how innovation, software, and hardware come together in real-world enterprise-scale engineering.

2.2 SLT Digital Labs

Introduction to SLT Digital Labs

SLT Digital Labs (Pvt) Ltd is the dedicated innovation and research subsidiary of Sri Lanka Telecom (SLT), operating as the technological nucleus for the SLT Group. Established to spearhead the digital transformation initiatives of SLT-MOBITEL, SLT Digital Labs focuses on developing cutting-edge solutions in areas such as artificial intelligence (AI), machine learning (ML), Internet of Things (IoT), cloud computing, and enterprise automation. The lab serves as an incubator for innovative ideas, fostering a culture of creativity and rapid technological adoption to maintain a competitive edge in the telecommunications industry.

Key Divisions and Their Functions:

2.2.1 Research & Development (R&D) Division

The R&D division is the cornerstone of SLT Digital Labs, dedicated to exploring emerging technologies and translating them into practical applications. This division works on developing prototypes, conducting feasibility studies, and implementing pilot projects that can be scaled across the SLT network. Projects often involve collaboration with academic institutions and industry partners to ensure the integration of the latest technological advancements.

2.2.2 Software Development and Systems Integration

This division focuses on creating robust software solutions tailored to the needs of SLT and its customers. Responsibilities include developing customer-facing applications, internal management systems, and integrating various software platforms to ensure seamless operation across different services. The team employs agile methodologies to deliver scalable and secure software products.

2.2.3. AI and Data Science Unit

Specializing in artificial intelligence and data analytics, this unit develops intelligent systems that enhance decision-making processes and operational efficiency. Projects include predictive maintenance models, customer behavior analysis, and AI-driven customer service tools. The unit leverages big data to provide actionable insights that drive strategic initiatives.

2.2.4. IoT and Smart Solutions

Focusing on the Internet of Things, this division designs and implements smart solutions for various applications, including smart homes, cities, and industrial automation. The team works on integrating sensors, devices, and networks to create interconnected systems that improve quality of life and operational efficiency.

2.2.5. Cloud Services and Infrastructure

This division manages the cloud infrastructure that supports SLT's digital services. Responsibilities include maintaining data centers, ensuring data security, and providing cloud-based solutions to both internal and external clients. The team ensures high availability and scalability of services through robust cloud architecture.

2.2.6. Innovation and Entrepreneurship Studio

Aimed at fostering a culture of innovation, this studio provides resources and support for employees and external entrepreneurs to develop and launch new ideas. Initiatives include hackathons, startup incubators, and innovation labs that encourage creative problem-solving and the development of new business models.

2.2.7. Digital Marketing and Customer Experience

This division focuses on enhancing the digital presence of SLT and improving customer engagement through targeted marketing strategies. The team utilizes data analytics to understand customer needs and tailor services accordingly, ensuring a customer-centric approach in all digital initiatives.

2.3 Advanced Engineering and Smart Systems Development

SLT Digital Labs' Research and Development (R&D) Division and Internet of Things (IoT) Division work hand in hand to drive innovation across the SLT Group's technology landscape. These divisions focus on transforming conventional telecom infrastructure into intelligent, automated, and efficient systems through advanced research, prototyping, and deployment of cutting-edge technologies.

As a trainee, I was primarily assigned to the R&D division, where I worked on several key projects. My major contribution was toward the Automated Antenna Alignment System, which involved designing and developing a mechanism to dynamically adjust telecom antennas based on real-time GPS and signal strength data. I engaged in hardware selection, firmware development, and enclosure design for this system. Another task I undertook was the mechanical design of a custom metal enclosure to protect sensitive telecom electronics from environmental factors. In parallel, I had opportunities to collaborate with the IoT division, particularly on areas like sensor integration and remote telemetry, which share many principles with my assigned projects. This experience enhanced my knowledge in control systems, embedded electronics, and wireless communication — all of which are foundational to SLT's future-ready digital infrastructure.

CHAPTER 03

PROJECTS AND CONTINUOUS LEARNING

3.1 AUTOMATED ANTENNA ALIGNMENT SYSTEM

3.1.1 Introduction

In modern telecommunications, precise antenna alignment is critical for maintaining signal quality, network coverage, and operational efficiency. Manual alignment methods are often time-consuming, labor-intensive, and prone to human error. To address this challenge, the R&D team at SLT Digital Labs initiated the development of an Automated Antenna Alignment System, designed to optimize antenna orientation in real time using GPS data and signal strength feedback. The system incorporates principles of mechatronics, automation, and control engineering to ensure maximum signal efficiency with minimal manual intervention.

3.1.2 Objective

The primary objective of this project was to design and develop a prototype system capable of autonomously aligning a telecom antenna by:

- Measuring real-time signal strength and GPS coordinates
- Adjusting the antenna's azimuth and elevation via stepper motors
- Optimizing orientation through feedback control algorithms
- Offering a user interface for manual override and signal monitoring

3.1.3 My Contribution

As part of the R&D team, I was assigned to lead the prototyping phase of the alignment system. My contributions included:

- Component Selection and Hardware Integration:
  I selected appropriate actuators (stepper motors), rotary encoders for feedback, and a microcontroller (Arduino Mega) as the core processing unit. I

also worked on integrating a GPS module and signal strength meter to the system.

- Mechanical Design and Enclosure:
  I designed the mechanical frame and antenna mount using SolidWorks, ensuring full range of motion in both azimuth and elevation. A custom metal enclosure was also designed to protect internal electronics from environmental conditions.
- Control Logic and Firmware:
  I implemented motor control logic using embedded C/C++ in Arduino IDE. A basic PID control loop was introduced to allow the system to stabilize the antenna once optimal signal was detected. Feedback from encoders and signal sensors was used to adjust motor positions in real-time.
- Testing and Calibration:
  After the hardware setup was complete, I performed testing to analyze how antenna orientation affected signal strength. The system was calibrated to avoid oscillation and overshoot, ensuring smooth and accurate positioning.

3.1.4 Outcomes and Results

By the end of the project cycle, the system was able to:

- Detect GPS location and real-time signal strength
- Automatically rotate the antenna to optimal orientation
- Allow manual adjustment via a software interface
- Operate smoothly under typical environmental conditions

The final prototype demonstrated the potential to reduce maintenance costs and improve network reliability, especially for remote and high-risk locations where manual antenna tuning is impractical.

3.1.5 Skills and Technologies Used

- SolidWorks for 3D CAD design

- Arduino Mega, stepper motors, encoders, GPS module
- Embedded C/C++ programming
- PID control systems
- Serial data communication and signal acquisition
- Practical wiring, soldering, and mechanical assembly

```
#include <AccelStepper.h>

#define dirPin 2
#define stepPin 3

AccelStepper stepper(1, stepPin, dirPin);

void setup() {
  stepper.setMaxSpeed(1000);
  stepper.setAcceleration(200);
  Serial.begin(9600);
}

void loop() {
  // Rotate to 90 degrees
  stepper.moveTo(200);  // Number of steps for desired angle
  stepper.runToPosition();
  delay(1000);

  // Rotate back to 0 degrees
  stepper.moveTo(0);
  stepper.runToPosition();
  delay(1000);
}
```

Figure 3.1: Stepper Motor code

3.2 EKB System with AI Integration

3.2.1 Introduction

As organizations scale, managing and retrieving internal knowledge becomes increasingly complex. At SLT Digital Labs, the Enterprise Knowledge Base (EKB) project aims to streamline this process by leveraging Generative AI to organize, search, and extract data from vast collections of technical documents, policies, and operational manuals. The system was designed to provide employees with instant, conversational access to structured and unstructured knowledge, improving decision-making, onboarding, and support efficiency.

3.2.2 Objective

The goal of the EKB project was to develop an AI-powered backend capable of:

- Ingesting documents (PDFs, Word files, Excel sheets) and extracting meaningful data
- Generating semantic embeddings and storing them in a vector database
- Enabling natural language queries using a large language model (LLM)
- Delivering context-aware, accurate responses with source citation

3.2.3 My Contribution

As part of the R&D team, I contributed to the early-stage implementation and architecture of the AI-driven backend pipeline. My responsibilities included:

- Data Ingestion and Preprocessing:
  I worked on the file ingestion module responsible for uploading and extracting text from various document formats. Using Python and libraries like PyMuPDF, python-docx, and pandas, I helped develop a pipeline to clean and segment document content for further processing.
- Embedding Generation and Vector Storage:
  I assisted in generating text embeddings using Amazon Bedrock and Hugging Face models, and helped store the vectors in a FAISS-based or OpenSearch-backed vector database. This allowed fast semantic search across thousands of document

segments.

- Query Interface and LLM Integration:
  I contributed to the setup of an API that connects user queries with the vector store. When a query is received, the system retrieves the top relevant text chunks and feeds them to a generative AI model (like OpenAI GPT-4 or LLaMA via LangChain), which forms a response based on context.
- Backend Implementation:
  I collaborated in designing the backend using Python (FastAPI), with support for document uploads, collection creation, and prompt handling. This included managing secure access, logging queries, and handling large-scale document operations.

3.2.4 Outcomes and Results

The EKB system successfully:

- Allowed users to upload a variety of enterprise documents
- Supported semantic search and conversational interaction
- Reduced the time required to find relevant internal information
- Offered a flexible platform for future expansion into chatbot interfaces, HR helpdesks, and internal support automation

The project demonstrated how AI can bridge the gap between raw enterprise data and actionable knowledge.

3.2.5 Skills and Technologies Used

- Python, FastAPI, LangChain
- Amazon Bedrock, Hugging Face Transformers
- FAISS / OpenSearch vector database
- PyMuPDF, python-docx, pandas (for document parsing)
- REST API development and testing

- Embedding generation and semantic retrieval workflows

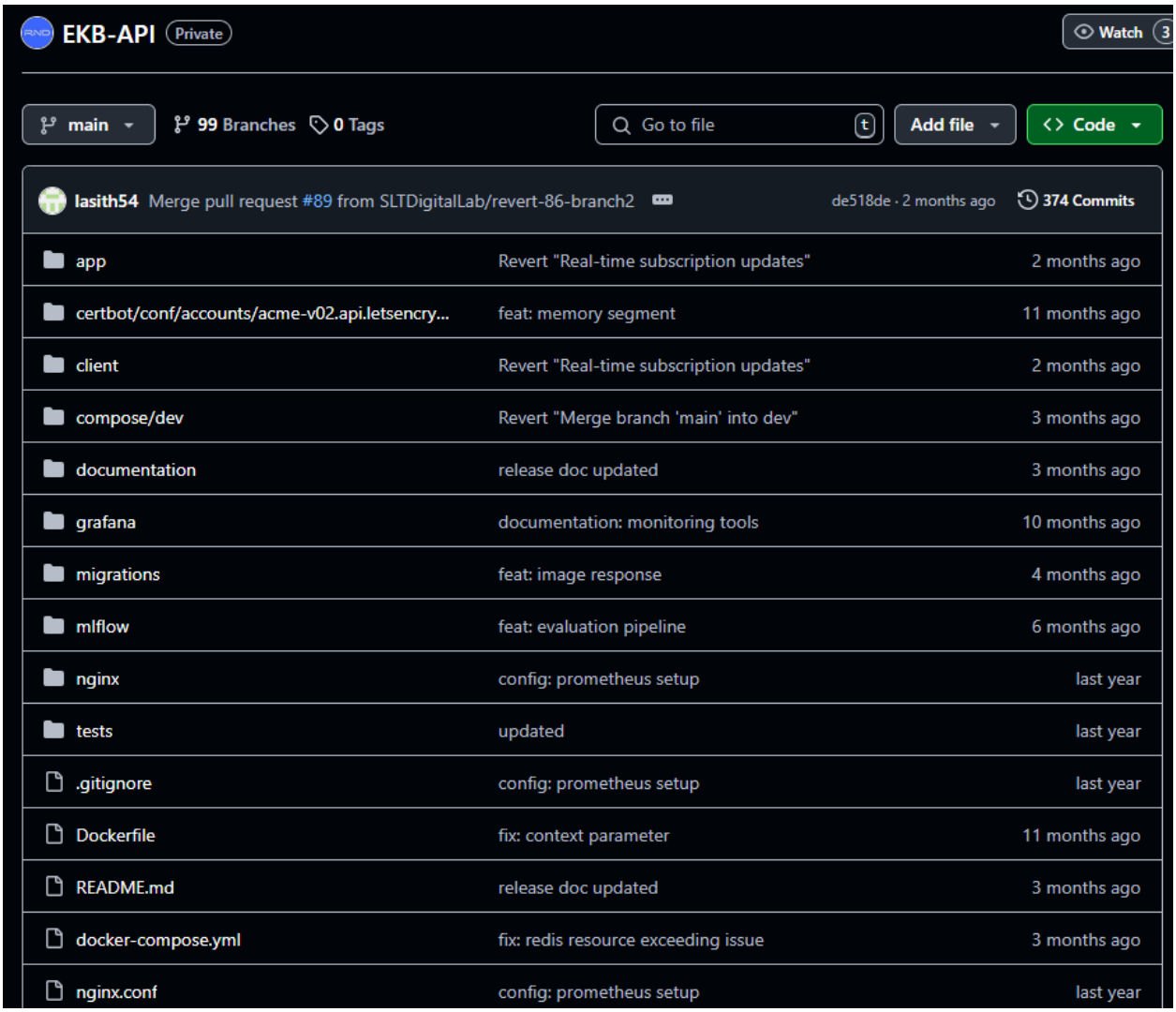

Figure 3.2: EKB project code base

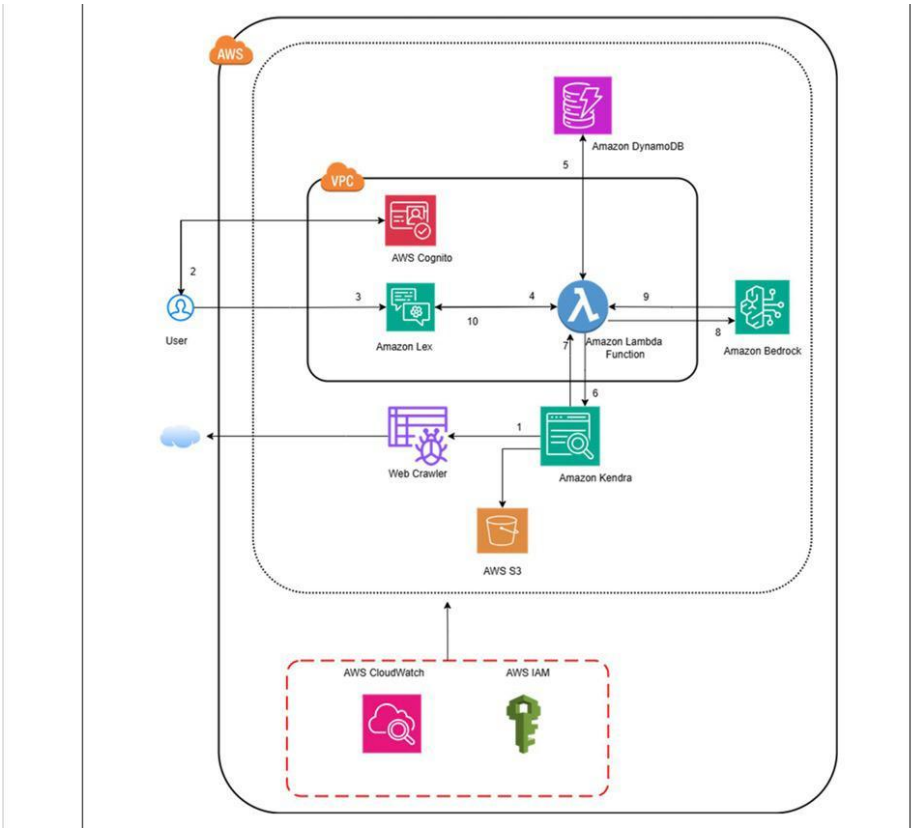

Figure 3.3: Project Architecture

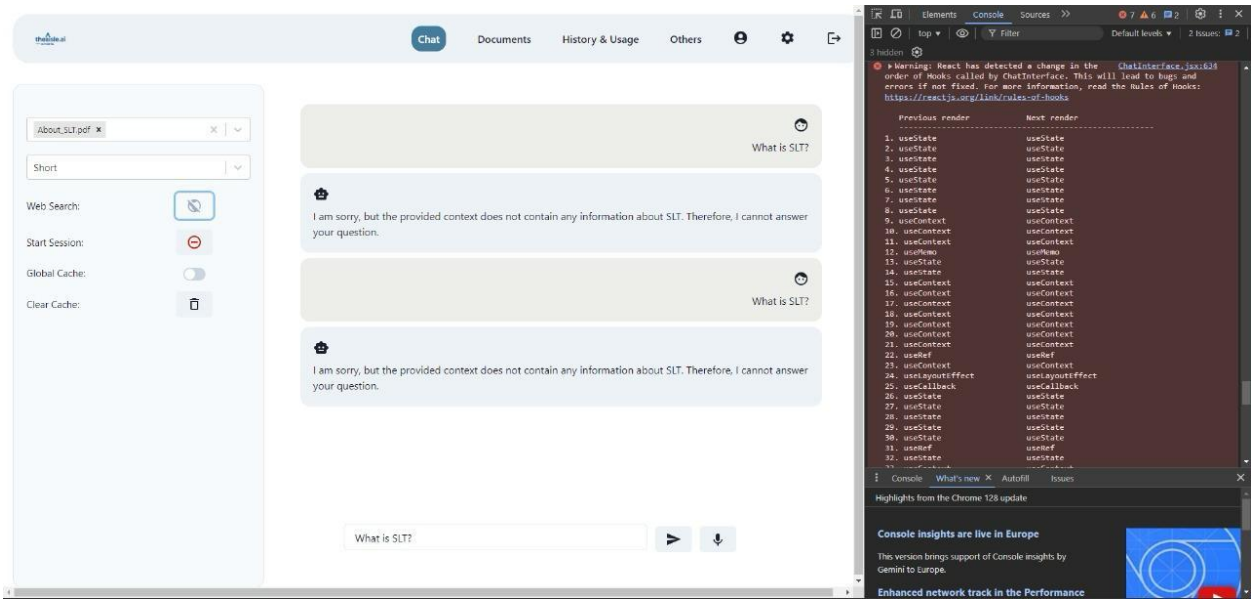

Figure 3.4: Errors faced

3.3 Design and Fabrication of a Protective Metal Enclosure

3.3.1 Introduction

In telecom environments, especially at outdoor or high risk sites, electronic equipment must be protected from harsh environmental factors such as moisture, heat, dust, and physical impact. At SLT Digital Labs, a requirement arose for a custom designed protective metal enclosure to house sensitive hardware components including microcontrollers, motor drivers, GPS modules, and signal analyzers used in R&D field tests. The enclosure had to be compact, weather resistant, and accessible for maintenance while ensuring safety and heat dissipation.

3.3.2 Objective

The goal of the project was to design a metal housing unit that would:

- Protect embedded control systems and electronics from external elements
- Support internal ventilation and cable management
- Maintain compactness while allowing easy access for hardware adjustments
- Be robust enough for both indoor lab use and outdoor testing environments

3.3.3 My Contribution

I was solely responsible for the full cycle of this design and assisted during fabrication. My work included:

- Requirement Gathering and Measurements:
  I first evaluated the dimensions and layout of the internal components, including microcontroller boards, power supplies, wiring, and cooling needs. I identified the ideal form factor and mounting strategies for both wall-mount and base installation.
- 3D CAD Modeling:
  Using SolidWorks, I modeled the enclosure with designated cutouts for ventilation, cable entry, mounting holes, and component placement. Emphasis was given to airflow dynamics and material thickness to balance durability and manufacturability.

- Thermal and Environmental Considerations:
  I designed passive air vents to aid in heat dissipation. The enclosure was also fitted with weather sealing gaskets to reduce moisture ingress, especially when used outdoors.
- Material Selection and BOQ Preparation:
  Mild steel with powder coating was chosen for strength and corrosion resistance. I prepared the Bill of Quantities (BOQ) and fabrication drawings, which were handed over to the workshop team for production.
- Assembly and Final Testing:
  Once fabricated, I supervised the mounting of internal components and helped ensure all fit and wiring layouts matched the design. Minor modifications were made to accommodate extra cabling during the testing phase.

3.3.4 Outcomes and Results

- Successfully delivered a rugged and neatly organized enclosure for SLT's field hardware.
- Ensured cable safety, heat dissipation, and protection from environmental exposure.
- The unit is now used for housing the core electronics of the Antenna Alignment System and other testbed projects at the R&D division.

3.3.5 Skills and Technologies Used

- SolidWorks for 3D mechanical design
- Material selection and fabrication knowledge
- BOQ preparation and technical documentation
- Collaboration with mechanical workshop technicians
- Cable routing and spatial planning for embedded systems

Figure 3.5: Metal enclosure unit

3.4 Continuous Learning

Industrial training at SLT Digital Labs provided an immersive learning experience that extended far beyond theoretical classroom knowledge. Being part of the R&D and IoT teams exposed me to real-world applications of advanced technologies and interdisciplinary collaboration across hardware, software, and telecommunications domains. Throughout the training period, I continuously engaged with new tools, concepts, and problem-solving techniques that have significantly enhanced my engineering mindset.

3.4.1 Technologies and Tools Used

During my internship, I had the opportunity to explore and work with a variety of tools and technologies, including:

- Programming Languages & Platforms:
    - Embedded C/C++ for microcontroller programming
    - Python for backend scripting and automation
    - Arduino IDE for firmware development
    - FastAPI for RESTful backend development
- Hardware and Control Systems:
    - Stepper motors, motor drivers (e.g., A4988)
    - Rotary encoders and GPS modules
    - Signal strength analyzers and sensor interfaces
    - Arduino Mega, ESP32, and other microcontrollers
- Mechanical Design and Fabrication:
    - SolidWorks for 3D modeling and CAD drawing
    - Material selection and enclosure prototyping
    - BOQ (Bill of Quantities) preparation and interpretation of mechanical drawings
- AI and Data Processing:
    - Amazon Bedrock for embedding generation
    - Hugging Face Transformers for text analysis
    - FAISS and OpenSearch for vector database operations
    - LangChain for integrating large language models into applications
- Document and Data Handling:
    - PyMuPDF, python-docx, pandas for parsing PDF, Word, and Excel files
    - File ingestion and semantic chunking techniques
- Version Control and Collaboration:

- Git and GitHub for version control and codebase management
- Project coordination via Jira, Trello, and internal communication tools

3.4.2 Knowledge and Skills Gained

Throughout the internship, I gained valuable knowledge in several key areas:

- Embedded Systems and Real-Time Control:
  I learned how to interface sensors and actuators with microcontrollers and apply real-time logic to drive hardware actions in response to changing conditions.
- Control Systems and PID Tuning:
  Through the antenna alignment project, I developed an understanding of feedback control loops and the basics of PID (Proportional–Integral–Derivative) tuning for smooth motor control.
- AI-Driven Data Retrieval Systems:
  Working on the EKB system helped me grasp how large language models (LLMs) and vector embeddings are used to make unstructured data searchable and meaningful in an enterprise environment.
- Mechanical Design Thinking:
  The metal enclosure project gave me experience in designing real-world mechanical solutions, considering environmental constraints, assembly feasibility, and component layout.
- System Integration:
  I learned to integrate hardware and software components into a cohesive system, taking into account communication protocols, power management, and spatial constraints.
- Professional Communication and Team Collaboration:
  Working with senior engineers, technical leads, and other interns taught me how to document work, report progress, and communicate effectively in a professional R&D environment.
- Adaptability and Problem Solving:
  I learned to debug hardware, test systems under varying conditions, and revise designs based on real-time constraints—essential skills for any engineering role.

3.5 Overcoming Challenges

Throughout my training at SLT Digital Labs, I encountered several challenges that tested my adaptability, problem-solving skills, and technical understanding. Each obstacle, however, became an opportunity to grow and learn more deeply about working in a fast-paced R&D environment.

3.5.1 Hardware Integration Issues

One of the early challenges was integrating multiple hardware components motors, sensors, GPS modules, and encoders within the antenna alignment system. Voltage mismatches and communication delays caused erratic behavior in the prototype. To address this, I carefully re-evaluated component datasheets, implemented protective circuits, and used logic level converters where necessary. I also learned to use serial debugging effectively to isolate and solve signal transmission issues between modules.

3.5.2 Mechanical Design Constraints

While designing the protective metal enclosure, space optimization was a major concern. Some of the components initially didn't fit as expected, and the enclosure lacked sufficient ventilation. I had to go back to the drawing board, rework the CAD model, and consult with mechanical supervisors for practical insights on mounting techniques and thermal clearance. These iterations helped improve both design accuracy and manufacturability.

3.5.3 AI Model Integration and Performance

During the EKB project, integrating the generative AI model with vector search proved challenging due to latency issues and large embedding sizes. Managing memory usage while ensuring fast response times required tuning both the retrieval pipeline and model inputs. Collaborating with the AI team, I explored batch processing and optimized query chunking strategies to improve overall system efficiency.

3.5.4 Time and Task Management

Balancing multiple tasks project documentation, weekly reporting, and prototype development was initially overwhelming. I tackled this by creating a structured weekly plan and setting clear daily targets. Using tools like Trello and maintaining a project journal helped track progress and stay organized.

3.5.5 Learning Curve on New Technologies

Being introduced to tools like LangChain, FAISS, FastAPI, and SolidWorks within a short period was intense. I overcame this by dedicating extra time after hours to study official documentation, follow tutorials, and seek help from my mentors and fellow interns. This self-driven learning approach proved effective in mastering new technologies quickly.

CHAPTER 4

TRAINING EXPERIENCE

4.1 Training Program Development

At SLT Digital Labs, the industrial training program was structured to give interns immersive, hands-on exposure to real-world projects aligned with their academic field. The program began with a comprehensive orientation session that covered the company's operations, safety guidelines, and expectations. During the first few days, I was introduced to the R&D team and briefed on ongoing projects that required engineering support. The training modules were not only technically focused but also designed to encourage critical thinking, collaborative problem-solving, and independent initiative. Weekly review sessions and technical discussions ensured that all interns could track their progress, seek feedback, and adjust their work plans accordingly. This structured yet flexible approach helped bridge the gap between theoretical knowledge and practical application.

4.2 Employee Work Management and Reporting

Work at SLT Digital Labs followed a structured professional schedule. I was expected to report by 8:30 AM and maintain regular work hours until 5:00 PM. Attendance was tracked through both daily check-ins and weekly supervisor reviews. I submitted weekly progress reports detailing the work completed, tools used, challenges faced, and tasks planned for the following week. These reports were reviewed during team discussions and one-on-one check-ins with my mentor. This system of continuous documentation and feedback not only encouraged accountability but also helped in maintaining a clear project timeline. In addition, project-related contributions were regularly updated to the team's shared development platforms, ensuring transparency and collaboration.

4.3 Safety and Security Management

SLT Digital Labs maintained strict policies around both physical and digital security. All technical systems and internal portals were protected through VPN access and two-factor authentication. Interns were issued temporary access credentials that limited permissions based on their project roles. During my work with microcontroller-based prototypes and mechanical enclosures, I followed lab safety protocols including proper handling of equipment, use of PPE (personal protective equipment), and safe soldering/assembly practices. Special care was taken when handling sensitive project files, especially in AI model integration and document ingestion processes. Clear guidelines on data privacy, professional conduct, and system usage were shared during the first week and reiterated during team briefings.

4.4 Risk Management

The R&D environment involved a number of risks including hardware misconfigurations, project delays due to component availability, and system failures during testing. To mitigate these, every task followed a testing-then-deploy approach. Before live testing of the antenna alignment system, we conducted motor simulations in isolated conditions. Backup hardware and power supplies were maintained to reduce project downtime. For software-related risks, version control systems like Git were used to track changes and quickly revert in case of failures. Weekly technical evaluations with mentors helped identify potential roadblocks early and plan corrective actions, ensuring steady progress even when facing unforeseen technical challenges.

4.5 Practice of Professional Standards and Engineering Ethics

Throughout the internship, I practiced punctuality, professionalism, and ethical responsibility in all activities. I consistently adhered to project deadlines, respected confidentiality agreements, and maintained courteous communication with colleagues and supervisors. In all engineering decisions from mechanical design to algorithmic logic I applied systematic analysis and industry best practices. During group discussions and review meetings, I actively participated while maintaining respect for diverse perspectives. I also ensured that all testing was conducted with care and without endangering equipment, data, or personal safety. This experience significantly strengthened my understanding of engineering ethics and workplace professionalism.

4.6 Quality Assurance Procedures

To maintain quality in both hardware and software projects, multiple QA methods were employed during my training:

- Component Testing: All motors, sensors, and modules were tested individually before integration.
- 3D Design Verification: Mechanical enclosures were validated through simulation in SolidWorks before physical fabrication.
- Firmware Debugging: Serial monitoring and debugging tools were used to verify sensor readings and motor control behavior.
- API Testing: Backend endpoints developed for the EKB system were tested using Postman and mocked inputs to ensure stable responses.
- Interface Testing: The GUI for the antenna system was tested for usability and responsiveness under simulated conditions.

- Documentation Reviews: All designs and codebases were reviewed with supervisors before submission or deployment.

These practices ensured a professional standard of delivery and helped reduce the risk of system failure during project demonstrations.

CHAPTER 5

SUMMARY AND CONCLUSION

5.1 Summary

My industrial training at **SLT Digital Labs (Pvt) Ltd**, from **29th July 2024 to 11th October 2024**, was a highly valuable and enriching experience. Assigned to the **Research and Development (R&D) division**, I had the opportunity to actively contribute to real-world engineering projects that integrated mechanical, electrical, and software systems perfectly aligning with my academic background in **Mechatronics Engineering**.

Over the course of the training, I was directly involved in three major projects:

- The **Automated Antenna Alignment System**, where I worked on the integration of GPS modules, motors, sensors, and control logic to develop a functional prototype.
- The **Enterprise Knowledge Base (EKB) System**, where I assisted in building a backend pipeline that uses AI to organize and retrieve internal documents intelligently.
- The **Design and Fabrication of a Protective Metal Enclosure**, in which I modeled and supported the physical build of a durable enclosure for field deployable hardware systems.

In addition to project specific learning, I gained broader interdisciplinary knowledge by observing and engaging with ongoing work across other divisions of SLT Digital Labs. I learned about the development of smart IoT solutions, network infrastructure management, cloud computing strategies, AI-driven automation workflows, and modern software development practices using agile methodology. This exposure helped me understand how different technological components work in unison within a large-scale telecom ecosystem. I also became familiar with cybersecurity protocols, digital customer experience platforms, and the importance of data privacy and system integration in enterprise environments.

These experiences helped me develop a practical understanding of embedded systems, control theory, CAD modeling, vector databases, and AI integration. I was also exposed to professional practices such as project documentation, team collaboration, risk management, and adherence to engineering ethics.

5.2 Conclusion

This industrial training period was a transformative stage in my academic journey. It allowed me to apply theoretical knowledge in a real-world environment and helped shape my problem-solving, technical, and communication skills. I was able to work with experienced engineers, contribute to meaningful innovations, and gain a deeper understanding of how multidisciplinary engineering solutions are developed and deployed in a large-scale telecommunications organization.

In addition to the hands-on experience I gained through my primary project assignments, I also benefited greatly from observing and engaging with diverse teams working on IoT solutions, AI research, and cloud infrastructure. This exposure broadened my perspective on how mechatronics integrates with other domains such as software engineering, network systems, and enterprise IT architecture. I developed an appreciation for the importance of teamwork, scalability, user-focused design, and the balance between innovation and operational reliability in enterprise-grade engineering.

Working in a fast-paced and innovation-driven environment like SLT Digital Labs reinforced my passion for embedded systems and intelligent automation. The experience not only broadened my technical knowledge but also instilled a strong sense of responsibility, time management, and professionalism qualities essential for any aspiring engineer.

I am grateful for the mentorship and support provided by the team at SLT Digital Labs, and I believe the insights and experience gained through this training will significantly contribute to my future career in engineering and technology.

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