DEVELOPMENT AND TESTING OF NEW THINQ DISPLAY OF REFRIGERATOR

A Dissertation submitted in fulfillment of the requirements for the Degree of

MASTER OF ENGINEERING

in

Power Systems

Submitted by

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Under the Guidance of

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DECLARATION

I hereby certify that the work which is presented in the dissertation entitled, **"Development & Testing of New Thinq Display of Refrigerator"**, in partial fulfillment of the requirements for the award of the degree *Master Of Engineering In Power Systems*, submitted to Electrical & Instrumentation Engineering Department of Thapar Institute Of Engineering & Technology (Deemed-To-Be- University), is an authentic record of my own work carried under the supervisions of **Mr. Anuj Kumar (Deputy Manager, LG), Mr. Sudhir Sharma (DGM – Team Lead, LG)** and **Dr. S.K. Aggarwal (Associate Professor, TIET)**. It refers other researcher's work which are duly listed in the references section. The matter contained in the dissertation has not been submitted, nei- ther in part nor in full, to any other degree of any other university or institute except as re- ported in the text and references.

Place : **Patiala** **Aditya Kumar Prasad**

Date : **1 July 2024** **Roll No. 802242001**

EXPERIENCE CERTIFICATE

LG

Certificate of Internship

Mr. Aditya Kumar Prasad

THAPAR UNIVERSITY,
PATIALA

For Successful completion of Internship in **Development Planning**
Project Title **Development and Testing of new Thinq Display of Refrigerator**

Duration : 01/08/2023 - 31/07/2024
For LG Electronics India Pvt. Ltd

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SENIOR G.M. - Noida HR

CERTIFICATE

This is to certify that the dissertation work entitled, "**Development & Testing of New ThinQ Display of Refrigerator",** is an authentic record of work carried out by **Mr. Aditya Kumar Prasad.** During his engagement as a master's student from July 2022 to July 2024, this project was carried out by additional guidance in partial fulfillment of the requirements for the award of the degree of "Master of Engineering in Power Systems" at Thapar Institute of Engineering & Technology, Patiala, Punjab during the academic year 2023-2024.

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It is certified that the above information made by the student is correct and true to the best of our knowledge and belief.

Sanjeev Aggarwal

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DECLARATION

I, Aditya Kumar Prasad, hereby declares that the project work entitled, **"Development & Testing of New ThinQ Display of Refrigerator"**, is an authentic record of my own work carried out at LG Electronics India Pvt. Ltd. as a part of the internship training that has been done during my final year of M.E.

I declare that I have successfully completed my industrial training project under the guidance of my industry mentor,

Mr. Anuj Kumar, August 2023 to July 2024.

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Date : 05.07.2024

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LIST OF FIGURES

ABSTRACT

In the present work, we have developed a new THINQ display for the refrigerators. This display was made with the objective of decreasing the CDR ratio in running models. A detailed procedure of the performance part selection done in LG Electronics standards is recorded in this work. Testing for the new display was performed in the lab of the company following strict standards set by government bodies for particular countries. The project was a development of the VT8, VT9, VT10, and VT11 refrigerator models.

Testing was conducted by a team at the various stages of development, and moisture testing was done in a chamber. Machine-to-machine variation was also checked and kept under the limit generated by the following three sigma. Volume and performance results were also compared with other benchmark companies to ensure healthy competition.

Keywords: Refrigerator, Performance, Testing, Development.

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CHAPTER – 1

INTRODUCTION

1.1 Introduction of the Company

Founded as a private company on October 1, 1958, LG Electronics began producing radios in 1959. With 77 subsidiaries globally and over 72,000 people, LG Electronics is one of the biggest players in the consumer durables market. There are five design centers and up to 27 R&D centers inside the organization. Home theatre systems, optical storage systems, CDMA phones, DVD players, and air conditioners for homes are some of its top-selling items worldwide. The global philosophy of LG is "Great Company, Great People," which holds that a great company can only be created by excellent people. The company's growth strategy is built around three key capabilities: people-centered leadership, market leadership, and product leadership. These enable "fast innovation" and "fast growth" inside the organization.

The company's robust corporate culture encourages creativity, a spirit of innovation, open management throughout its subsidiaries, and the belief that staff members should be given the opportunity to assume leadership roles. The third-biggest Korean company, LG began doing business in India twelve years ago. LG has its corporate headquarters and production facilities located in Noida. Its network of seventeen branches is dispersed throughout India's major cities. People are the company's most valuable resource, according to LG. In a poll of several business entities around India, Business Today ranked it as the eighth best employer to work for in India. The company's HR philosophy is based on the phrase, "At LG we always put people first." With a champion attitude and a presence in more than 175 countries worldwide, LG considers itself to be a global company.

1.2 Some Facts at Glance about LG

- Third-biggest producer of electronics appliances worldwide, South Korean MNC with its headquarters located in Seoul.

- LG maintains numerous international partnerships and joint ventures with numerous other major corporations. Some of the major ones are Caltex, Philips, EDS, Honey Well, Hitachi, and so on.
- Founded in October 1958, LG entered the Korean market as Lucky Gold Star, a chemical firm, 58 years ago (1958–10) as Gold Star, and 1995 as LG Electronics.

1.3 Literature Survey

One of the LG groups that included Goldstar was Lak-Hui Chemical Industrial Corp., a brethren company that is currently LG Chem and LG Households. On February 28, 1995, Goldstar amalgamated with Lucky Chemical and LS Cable, renaming the company Lucky-Goldstar before ultimately becoming LG Electronics.

In 1970, Goldstar became public, and by 1976, it was turning out a million televisions a year. Goldstar's first foreign factory opened its doors in 1982 and was located in Huntsville, Alabama. Goldstar formally embraced the LG Electronics name and a new company emblem in 1994. Four years later, in 1995, Zenith, a US-based TV manufacturer, was absorbed by LG Electronics.

As of 2013, LG Electronics ranked as the second-largest LCD TV manufacturer globally, demonstrating its significant influence in the global consumer electronics sector. LG saw a 14% increase in brand growth in 2006 and was ranked among the top 100 global brands by 2005. In 2009, LG Display, one of its affiliates in display production, held the title of largest LCD panel maker globally. LG Electronics joined the smartphone market in 2010. Since then, LG Electronics has persisted in creating a range of electronic goods, including the first 84-inch ultra-HD TV available for retail purchase worldwide.

1.4 The Significance of Logo

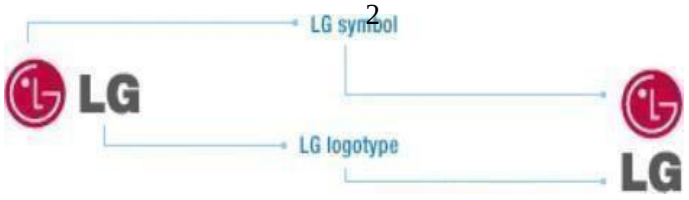


Fig 1.4 LG Logo

The globe, future, youth, humanity, and technology are represented by the letters "L" and "G" arranged in a circle. Humanity forms the basis of our ideology. Furthermore, it symbolizes LG's endeavors to maintain strong ties with its clientele worldwide. The stylised representation ofa human face in the distinctive LG Red hue and the LG logo in LG Grey make up the symbol.

The primary hue, red, conveys a strong sense of LG's warmth and dedication to providing the best. As a result, this symbol's color or shape must never be altered. The globe is represented by the circle. The symbol's stylized representation of a happy face exudes warmth and approachability. In general, the world, future, youth, human, and technology are all represented by LG's symbol.

The distribution of the design is as follows:

- **The one eye:** self-assured, goal-oriented, and concentrated.
- **Upper- right hand space**: This, which was purposefully left asymmetrical and blank, symbolizes LG's inventiveness and flexibility.
- **Colors:** The primary hue, LG Red, conveys a strong sense of friendliness and LG's dedication to excellence. LG Grey is a symbol of dependability and technology.

1.5 The Vision of Company

LG Electronics wants to be renowned as a company that can satisfy its global customers with revolutionary digital products and services. To achieve this, the firm plans to develop quickly and innovate quickly, positioning itself as a truly global digital leader in the twenty-first century.

Fig 1.5 LG Vision

LG Electronics has established its medium- and long-term objectives to be in the top three global information, communications, and electronics companies. In order to fulfill its goal of becoming the global market leader, the firm plans to use its core competencies of people, market, and product leadership as well as strengthen its corporate culture of teamwork and fun work environment.

1.6 LG Philosophy

"To create value for customers through management based on esteem of human dignity" is the management philosophy. The goal of LG is to make every house in the world a happy place to live. LG's logo is consistent with their mission. The five main principles represented by the happy face logo are World, Future, Youth, Human, and Technology. LG thinks that if these components were combined well, the organization would have a stronger future. In or- der to create, integrate, and implement technologies that would allow for product and service customization and beyond customer expectations, LG has been looking into these avenues. LG wants to make every family's life healthier and better.

Fig 1.6 LG Plant Greater Noida

1.7 Goal

LG's corporate business management will promote positive global influence while minimizing negative effects on society and the environment.

Fig 1.7 Goal of the Company

1.8 Various Departments and their function

- **Research and Development:**

At APSIT, a Research and Development cell was created to foster an inventive and research mindset in both staff and students. R&D Cell gives young brains in the Institute a platform to flourish in creativity and innovation. Only through rigorous R&D efforts can novel discoveries be made.

- **Procurement:**

By creating contracts, issuing vendor purchase orders, and negotiating prices with vendors, the procurement department provides internal services to its clients. In big businesses, the procurement department's job is to keep the business financially stable.

- **Accounts:**

The division within a business that handles all facet of accounting, including payroll, accountant ledger maintenance, financial statement production, and payments from customers and bills, etc. They oversee the business's international economic component to keep things simple.

- **Materials:**

The structure, characteristics, and manufacturing process of a material are studied by the materials department. They also create novel materials and cutting-edge production techniques. In order to guarantee that materials are available when needed to fulfill production schedules, materials also uses inventories and production requirements for planning and control. Managing logistics, stock levels, material quality, pricing, and other factors are all included in this material planning.

- **Production:**

Through a number of production procedures, the functional area known as production is in charge of converting inputs into final outputs. The production manager is in charge of ensuring that raw materials are supplied and that finished goods are produced efficiently. The continual good operation of a company, a good, or a service is guaranteed by quality management. Quality planning, quality assurance, quality control, and quality improvement are its four primary parts. The goals of quality management include both achieving high standards for goods and services as well as their methods.

- **Exports:**

Facilitating the sale of goods to nations in dire need of them. increasing the market for products by manufacturing them in excess of what is needed. obtaining currency via exports.

1.9 LG Products:

❖ LG Refrigerators:

Refrigerators with a range of styles, such as French Door refrigerators, Side by Side refrigerators, Top-freezer refrigerators, Bottom freezer refrigerators, and Door-in-Door refrigerators, are equipped with smart features, ample space, And the newest advancements in technology. With cutting-edge features like Its unique Linear Compressor Technology, which offers the best cooling, operational efficiency, and dependability, LG offers a broad selection of revolutionary refrigerated air conditioners.

❖ LG Frost Free Refrigerators:

LG has introduced a wide selection of feature-rich frost-free diamond-cut refrigerators, with capacities ranging from 230L to 751L. The company presently offers six variations with a capacity of 230 liters, four variants with a capacity of 250 li- ters, and five variants with a capacity of 280 and 310 liters, re- spectively. The company also introduced two versions with capacities of 350 and 390 liters, respectively.

❖ LG Washing Machine:

The newest front-loading TROMM series drum washing machines have been introduced by G Electronics. Fuzzy Logic technology, one of its cutting-edge WASH features, makes sure that as soon as you push the start button, intelligent sensors will recognize the water level and amount of laundry. To offer you the ideal WASH, adjustments are then made to the water levels and cycle time dependent on the laundry load. In order to provide the greatest washing results, Fuzzy Logic also recognizes machine

imbalance and excessive foam development and makes adjustments. LG

TROMM provides you with a simple and hygienic wash at the push of a button, while also saving energy and water. The best machines for washing and rinsing performance are those in the Turbo Drum and 3-step WASH line.

❖ **LG Microwave Ovens:**

The Solar DOM and Wave DOM, two of LG's premium microwave ovens, have been released. With its innovative Light Wave Technology, which allows for three times faster cooking, superior nutrient retention, higher energy efficiency (saving 50%), and high levels of convenience, the LG Solar DOM is currently the best microwave oven on the market. It saves space and is simple to clean thanks to the circular cavity design.It features a Smart Guide Display, a Multi Rotisserie grill, and an Indian Auto Menu option. For customers with built-in kitchens, there is now the option to pur- chase an installation kit.

❖ **LG Air Conditioners:**

For cool, pure, and healthy air, LG has introduced a large selection of window and split air conditioners with Health Air System. LG has developed ACs with plasma technology, which aids in dust and microscopic particle removal to get rid of unpleasant smells and stop allergic reactions. A range of 0.75 to 4 tons is available. Along with a vast selection of window and split air conditioners, it also features tower-type and multisplit air conditioners.

❖ **LG Water Purifiers:**

For your convenience, G True Water Purifiers offer a 2- in-1 Water Solution that includes a UF Filter system. Dual protection stainless steel tank, mineral booster, smart display, water tray, and five-stage RO filtration system are some of its primary features. There is a fruit and vegetable cleaner on the side of the purifier. It is very adept at clean-

ing fruits and vegetables and even conserves water.

❖ **LG Plasma Display Panels:**

A new level of technological perfection has been reached by LG Electronics among the manufacturers of plasma display panels. Internationally, the PDP is offered in sizes 40, 42, 50, 60, and 71 inches. LG boasts panels ranging from the thinnest in the world (78 mm) to the largest (71"). The company offers "the largest range of models in the PDP category," making it the only brand in India. LG's PDPs are the best-made plasma panels ever thanks to cutting-edge features including double window screens, orbiters, flexi PIP, and image stick minimization.

❖ **LG Notebooks:**

Two high-end, cutting-edge notebooks from LG have been released. They are built on the most recent Napa platform, which has two CPU cores and was created in India by Intel. When processing several tasks, a computer with dual cores uses

its two CPU cores to provide a 30% boost in performance. These two LG notebook model shave a 15.4-inch widescreen and a 15-inch TFT, respectively. They are the LG P1 Express Dual and LG M1 Express Dual.

❖ **LG Smartphones:**

Featuring small, fashionable patterns With LG phones, you can get the newest technology, high-resolution cameras, HD displays, the fastest CPUs, and the newest apps. with user- friendly Android operating systems. With only one tap, these smartphones enable you to do more.

❖ **LG Compressors:**

LG Compressor and Motor achieves cutting edge eco-friendly and energy-saving technology to deliver significant and unique values to clients in a sustainable manner. To ensure that all of our partners are satisfied, LG is constantly developing a group of highly precise machining and assembly technologies from accumulated techniques

for producing sustainable world-class components. We also provide inverter totalsolutions that are optimized for residential and commercial environments.

CHAPTER-2

THINQ DISPLAY

2.1 What Is ThinQ Display?

To keep it short and simple, LG Thinq is a smart technology installed on certain LG home appliance models that works with artificial intelligence (AI) to communicate with each of your other smart appliances to provide you with the best user experience possible with the Thinq app you can easily check on the smart appliances from anywhere. Track the status of your laundry cycle, see when your refrigerator & water filters need replacing, and send cooking instructions straight to your oven. Plus, you can control your range or oven with the sound of your voice via a Google Assistant or Alexa-enabled device. You can easily take care of your appliances with ThinQ Care proactive maintenance and diagnostic notifications. To help you save time and money while maintaining the best possible condition for your appliances, ThinQ will alert you to possible problems. You can personalize your smart appliances using ThinQ. Utilize the newest features by having software updates wirelessly delivered to your appliances. Install updates and new features according to your preferences and way of life.

Fig 2.1 ThinQ Display

CHAPTER-3

PROBLEM STATEMENT

3.1 Problem Formulation

After testing various parts of the display and removing Diode 105 and Diode 106, the same problems were occurring as moisture from the backplate of the Freezer door did moisture testing.

1. Problem in connector design
2. The harness design (group of wires) was not able to connect with the connector properly
3. Moisture coming on Display PCB
4. LEDS were found broken due to properly not soldering
5. Switches were not working on PCB
6. In Display PCB the connector Pins get moisture from moisture

In ThinQ display after doing several research on parts and chamber testing the main issue was the connector was getting moisture from the back plate due to the moisture PCB was working Properly and the company was getting lakhs of rupees monthly losses.

Fig 3.1 ThinQ Display PCB

Fig 3.2 ThinQ Display PCB Back Panel

CHAPTER-4

DISSCUSION & RESULTS

After discussion and testing procedure and also testing through chamber machine and the solution Were came out as the

- Display PCB spray-coated (silicon) on both sides.
- The connector position changed from above to bottom and the harness dimension increased for connecting with the connector.
- Switch build-in quality changed.
- LEDs were coated after soldering.
- Connector pins dimension changed.
- Tested in Moisture chamber and Display working properly.
- Connectors were spray-coated to make it rust-free.
- After successfully developing a new THINQ display last testing on the jig display machine was done.

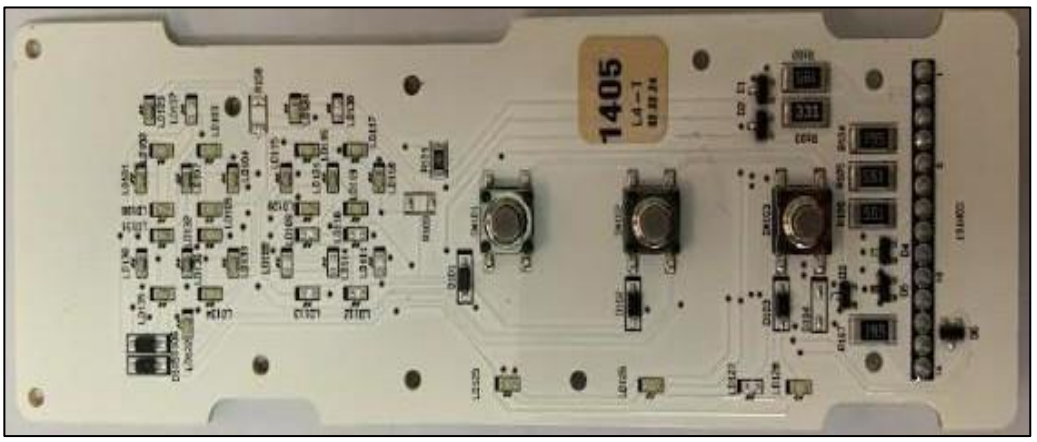


Fig 4.1 ThinQ display Pannel

Fig 4.2 ThinQ Display Back Panel

ThinQ Display Testing:

- Ease of use, touch interface, voice control.
- Information clarity, accuracy, and comprehensiveness.
- Appliance control & monitoring, real-time data.
- Smart home integration, device compatibility.
- User personalization, profiles, preferences.
- Perceived value, user satisfaction, impact.

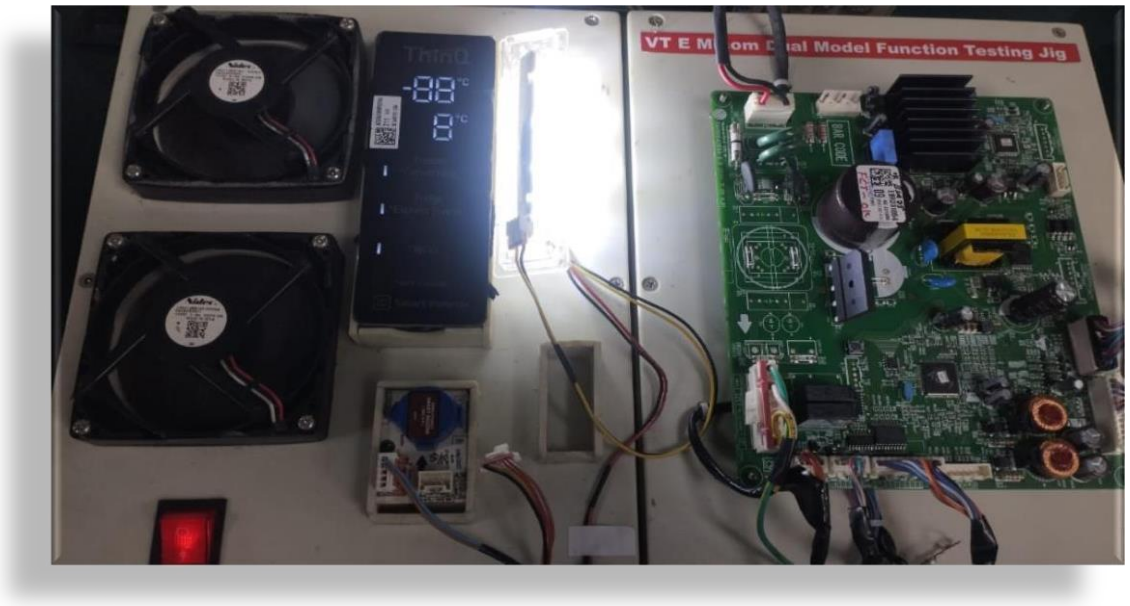


Fig4.3 VT E MICOM Dual Model Function Testing Jig

Fig 4.3 shows that first, we connect the VT model PCB with JIG and the connecting wires with the PCB. We can use the JIG for testing purposes. Two buttons of ThinQ we can press Display show the three zeros the work is done properly this the meaning of the three zeros no error is detected. ThinQ display has multifunctional but the main function is change's the refrigerator temperature of cooling.

CHAPTER-5

TRAINING WORK

5.1 Industrial Training

The Industrial Training program provides pre-professional work experience with specific assignments and responsibilities. Industrial Training should be relevant to a student's personal career interests and academic courses of study, serving as a bridge between university and the world of work. Productive Industrial Training helps students make informed decisions and improve their marketability after graduation. My training work is based on the Development of Refrigerator Displays and product study.

5.2 Phases Involved In Development

Main work done: Data Rendering

- A data bank is created from competitor USP (Unique Selling Proposition) features.
- (Including Whirlpool, Samsung, Godrej, Panasonic etc.).
- Different plastic and steel materials used for Washing machines are also studied.
- New modifications to the existing machines are suggested.

5.3 Product Planning:

Different parts required for the development of the concept are identified.

- Various world-wide manufacturers of related product and their specifications and quality standards are viewed different modifications in parts of existing machine are identified so that the new feature fits in perfectly.
- Various factors like flow of liquid due to gravity, losses in the movement, viscosity are considered.
- It is modelled in 3D, (UG NX7.5) such that parts are properly aligned, and there is no hindrance to the connectors being attached.
- The new feature and the new modified parts are then assembled with the existing machine

5.4 Product Verification:

1. Product Reliability

Energy Consumption:

The purpose of this measurement is to determine the electric energy and the quantity of cold water consumed for the particular operating cycle selected.

Temperature Rise Test:

Purpose: The purpose of this test is to confirm whether there is over temperature rise in advance when the and its accessories are in use.

Drop Test:

Purpose: Drop test is conducted to test the resistance of the product when it is dropped from certain height. Also, the Indian road conditions are simulated which the product faces during its transportation.

5.5 FPA (First Part Approval)

- Marking up drawings for critical dimensions.
- Measuring the dimensions.
- Use of various instruments.
- Deciding OK/NG/ Minor Acceptance based on tolerance and criticality of dimensions.

CHAPTER-6

SOFTWARE USED DURING TRAINING

6.1 Unigraphics (NX 11)

NX is one of the world's most advanced and tightly integrated CAD/CAM/CAE product development solutions. Spanning the entire range of product development, NX delivers immense value to enterprises of all sizes. It simplifies complex product designs, thus speeding up the process of introducing products to the market.

The NX software integrates knowledge-based principles, industrial design, geometric modeling, advanced analysis, graphic simulation, and concurrent engineering. The software has powerful hybrid modeling capabilities by integrating constraint-based feature modeling and explicit geometric modeling. In addition to modeling standard geometry parts, it allows the user to design complex free-form shapes such as airfoils and manifolds. It also merges solid and surface modeling techniques into one powerful toolset. Unigraphics is a complete package of Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), and Computer Aided Engineering (CAE) systems that can be used to automate design and production processes. The present-day CAD/CAM development focuses on efficient and fast integration and automation of various elements of design and manufacturing along with the development of new algorithms.

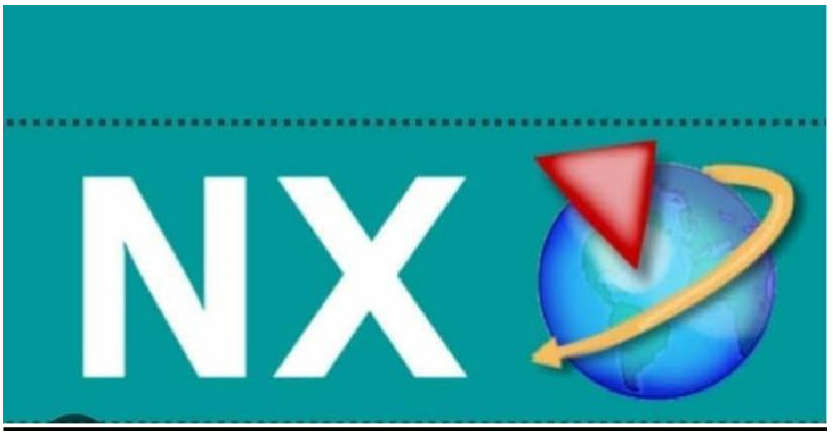


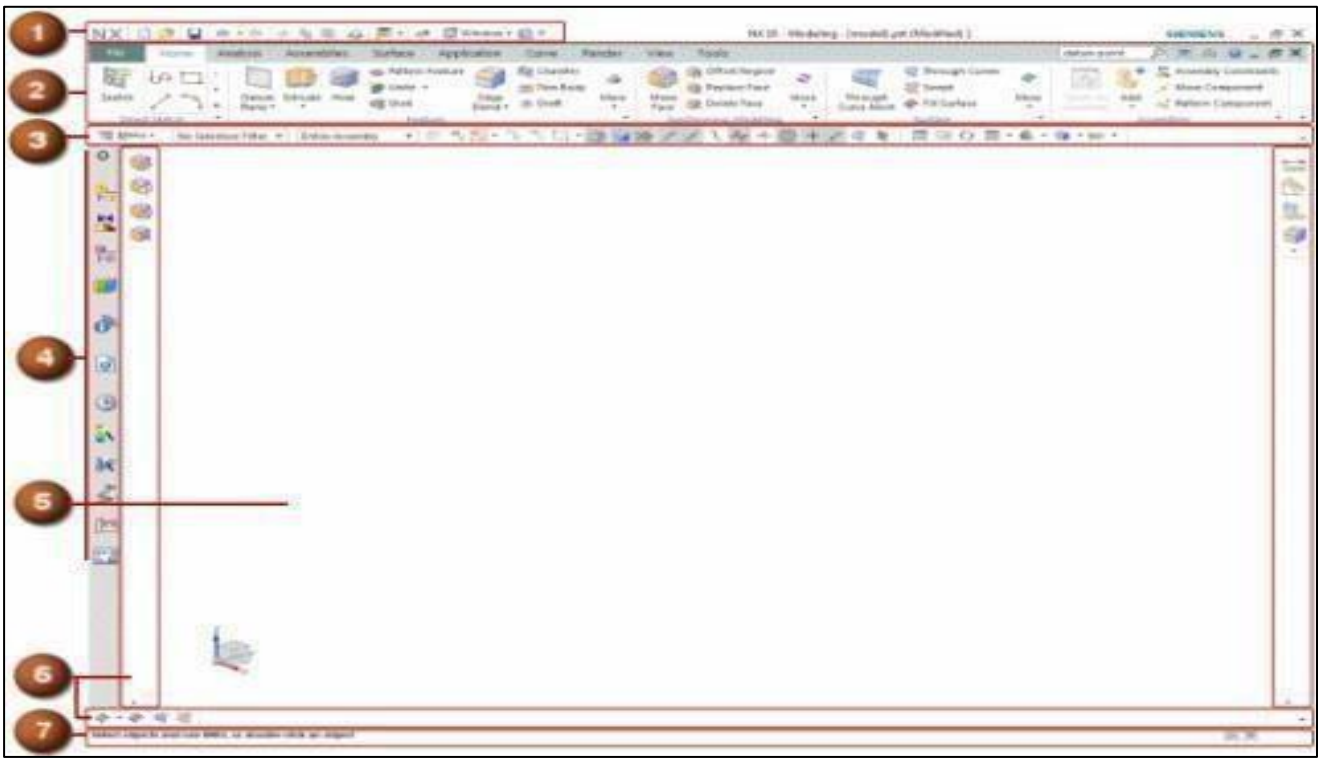
Fig 6.1 NX Logo

CAD: Computer-aided design (CAD) is the use of computer systems to aid in the creation, modification, analysis, or optimization of a design. CAD software is used to increase the productivity of the designer, improve the quality of design, and improve communications through documentation. CAD can convey information like material, processes, dimensions, and tolerance.

CAM: CAM technology involves computer systems that plan, manage, and control the manufacturing operations through a computer interface with the plant's production resources. One of the most important areas of CAM is numerical control (NC). This is the technique of using programmed instructions to control a machine tool, which cuts, mills, grinds, punches, or turns raw stock into a finished part. Another significant CAM function is in the programming of robots. Process planning is also a target of computer automation.

6.2 NX Window Interface:

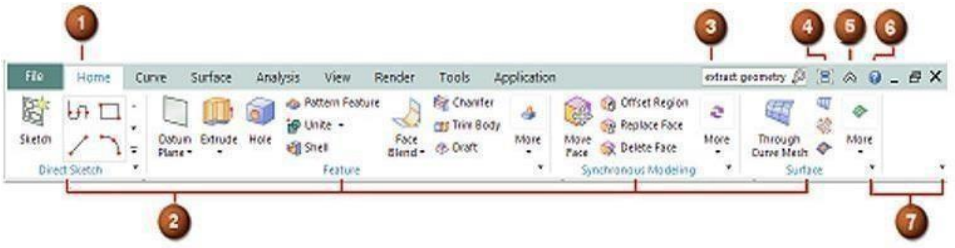
The NX Windows interface provides access to frequently used commands with a minimum number of mouse clicks while maintaining a maximum graphics window area.



#	Component	Description
1	Quick Access toolbar	Contains commonly used commands such as **Save** and **Undo**.
2	Ribbon bar	Organizes commands in each application into tabs and groups.
3	Top Border bar	Contains the **Menu**, **Selection Group**, **View Group**, and **Utility Group** commands.
4	Resource bar	Contains navigators and palettes, including the **Part Navigator** and the **Roles** tab.
5	Graphics window	Lets you model, visualize, and analyze models.
6	Left, Right, and Bottom Border bars	Displays the commands you add.
7	Cue/Status line	Prompts you for the next action, and displays messages.

Fig 6.2 NX Interface and commands

6.3 NX Ribbon Bar:



#	Component	Description
1	Tab	Organizes commands into groups of related functions in each application.
2	Group	Organizes commands by function on each tab. Related commands appear in lists and galleries.
3	Command Finder	Finds commands.
4	Full Screen	Maximizes screen space.
5	Minimize Ribbon	Collapses the groups on the Ribbon tab.
6	Help	Displays on-context Help (F1).
7	Ribbon Options	Lets you turn on or turn off commands in each group.

Fig 6.3 NX Ribbon

Modules in NX11.0:

- Solid Modeling
- Sheet Metal
- Shape studio
- Drafting
- Assembly
- Advanced Simulation
- Motion Simulation
- Manufacturing

CHAPTER-7

Project Undertaken During Internship

7.1 Work undertaken

- ECN/ECOs, changes related to drawings and designs.
- New Model Development

7.2 Objective of work undertaken

7.2.1 Line related issues and their management:

This plays a major role in our department. Any issues related to the production line have to be thoroughly studied and then a counteraction has to be given by the R&D team within a defined timeline to avoid line losses. These issues include: Mechanical parts malfunction, scratches due to improper handling, design and actual part mismatch issue etc.

The LQC (Line Quality Clearance) & OQC (Outdoor Quality Clearance) checks for the issues related to the line and then a report is generated which is sent to the R&D team for counteraction. The R&D team then has to provide a thorough report explaining the issue and the reasons behind the issues have to be enlisted. After this, a complete action plan has to be prepared by our team, while coordinating with the related departments and the suppliers, to resolve the encountered issues.

7.2.2 ECN/ECOs changes related to drawings and designs:

This is the most basic thing that we do in the R&D department. Every change that the R&D department does has to go through a complete process. ECO refers to Engineering Change Order & ECN refers to Engineering Change

Note: It is generally a power point presentation in which we first explain the issue the briefly. Then, we discuss about the feasible solution regarding the issue and the dimensional analysis of the part. At last, we add a plan of action in which we give the complete schedule of the to resolve the issue.

7.3 New Model Development:

There is a complete step by step process behind every new model development.
Firstly, the need of customer and market trends are kept in mind for the designing phase of the New Model Development. Then, we must take an approval from HQ in Korea regarding the New Model Development.

It includes all the costing, testing process and the complete step by step planning of the New Model. In this the newly made design is completely checked and analyzed using different software like UG – NX, Fusion 360 etc.

- Once the approval is done, meetings are conducted between with suppliers and different related departments for smooth conduct.
- After that the testing starts, firstly PV- Part Verification is done in which the part is visually inspected for any issues related to the appearance of the part.
- Secondly comes DV-Design Verification, in this the part is dimensionally analyzed according to the drawing of the part.
- Finally, the trials are done in which QA members are also involved along with R&D Team.
- and calibrations. Within these ranges of light, calibrations are needed on the machine using standards that vary in type depending on the wavelength of the photometric determination.

Issues: -

Mismatch between Indian product and Korean product (headquarter).

Root cause: -

Running Color is Free silver not matching with Global Standard.

Analysis: -

There is a Deviation in the L, a, b Values of running color (0.1~0.2). The sample chips of different suppliers of Korea and India are shown below, Korean (Akzo Nobel), and India (Saboo coating).

Improvement: -

1. Request Korea for color chips samples for standardization.
2. After receiving these chips or samples of free silver, these chips sent to local supplier for color development.

3. LG India purchased New Spectrophotometer for L, a, b measurement to standardize the color used to avoid deviation.
4. When the new samples from Indian supplier received, measurement and testing has been done on the new paint samples to match the global standard.
5. After all the measurement and testing, these trial samples with their data sent to Korea for Inspection and approval.
6. Then after approval from Korean team from Korea head quarter, goes ahead for mass production.
7. During mass production, Monitoring was done by me, for regular 15 Days, after that, the standard (l, a, b) was defined on basis of 15 days data /readings of L, a &b.
8. After all this, implementation has been done for whole production.

CHAPTER-8
OVERVIEW OF REFRIGERATOR PERFORMANCE

This chapter focuses on the operation of refrigerators and the proper way to follow the refrigerator cycle. This will provide a succinct and useful summary of the refrigerator's performance, which will be useful in elucidating its testing aspect. Currently, every cycle component and After explaining their calculations, the cycle that is followed needs to be explained. The figure 4.1 that follows provides the most explanation for this.

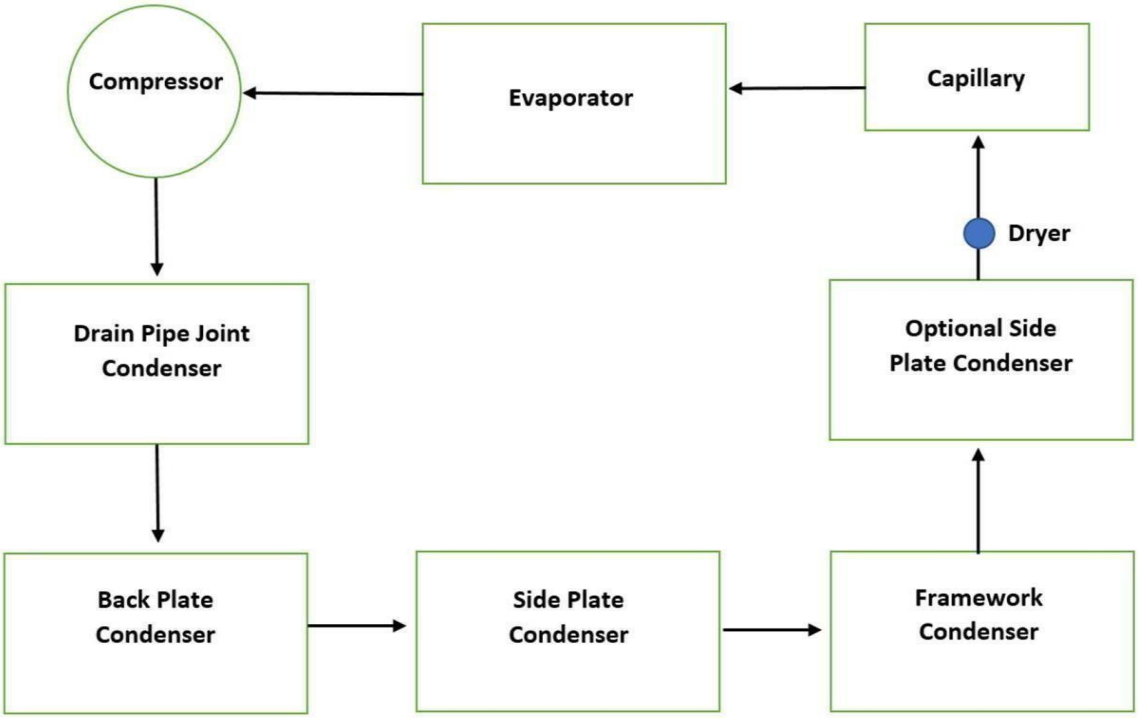


Figure 8.1 Flowchart of Refrigerant flow through the cycle parts

Working Cycle

The work can be explained as follows:

- When the machine is manufactured online, the required amount of gaseous refrigerant is filled inside the compressor. When the compressor runs, it compresses the gas increasing its pressure and temperature, and discharges it to the condenser. The condenser, as mentioned earlier, is divided into 4 components.

- Firstly, the refrigerant is discharged into the drain pipe joint condenser. This is a heat exchanger designed like a coil. It is placed on a drain tray. The drain tray is where the melted water from the defrost drops into. The water being ice cold, assists in heat exchange with the drain pipe condenser by taking away its heat and evaporates itself. The refrigerant undergoes sensible cooling in this section.

- Next, the refrigerant moves into the Back Plate Condenser. This is attached and pasted on the back plate of the machine. Natural convection from the surrounding air is the mode of heat exchange and this section also
- contributes to the sensible cooling of the refrigerant.

- From the back plate, the refrigerant goes to the side plate condenser which, in our model, is present at the left side from the front view. Also contributes to sensible cooling.

- From the side plate, it goes to the framework condenser. This is situated on the front side of the refrigerator along the framework. Here, the phase change of the refrigerant takes place.

After the condenser, the refrigerant flows through the dryer. The dryer is a small component that has a filter within it. Its function is to absorb any moisture or impurities which anyhow might have entered the cycle. From the dryer, it moves into the thin capillary. The capillary drops the pressure and does the main cooling of the refrigerant, taking it to temperatures below -25°C. The capillary is brazed with the suction which is the most important point because this is where Liquid to Suction Heat Exchange (LSHX) takes place. Referring to figure LSHX- Liquid refrigerant at the exit of the condenser is of the same temperature as the ambient. It is a saturated liquid state (point 3). Suction is the pipeline that joins the evaporator outlet to the compressor inlet. The inlet at suction is nearly saturated vapor at a very low temperature (point 6). So the concept of LSHX is to braze the capillary to the suction which promotes a counter-flow heat exchange between the two (3-4 is brazed with 6-1). This provides sub-cooling inside the capillary and also keeps extracting heat up to the evaporator inlet, thus greatly increasing the refrigeration effect. Inside the suction, from the inlet, the nearly saturated vapor refrigerant starts extracting heat from the capillary right down till the compressor inlet, which means the refrigerant gets superheated. This superheating eliminates any form of risk of liquid refrigerant

entering into the compressor, which if unchecked, can cause serious damage to the compressor. Relying solely on After condenser, the refrigerant flows through the dryer. The dryer is a small component that has a filter within it. Its function is to absorb any moisture or Impurities which anyhow might have entered the cycle.

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In this way, the cycle continues as long as the compressor is running. The running of the compressor, its duration, cut-off, and start-up is decided by the achievement of temperatures inside the compartment and is explained ahead.

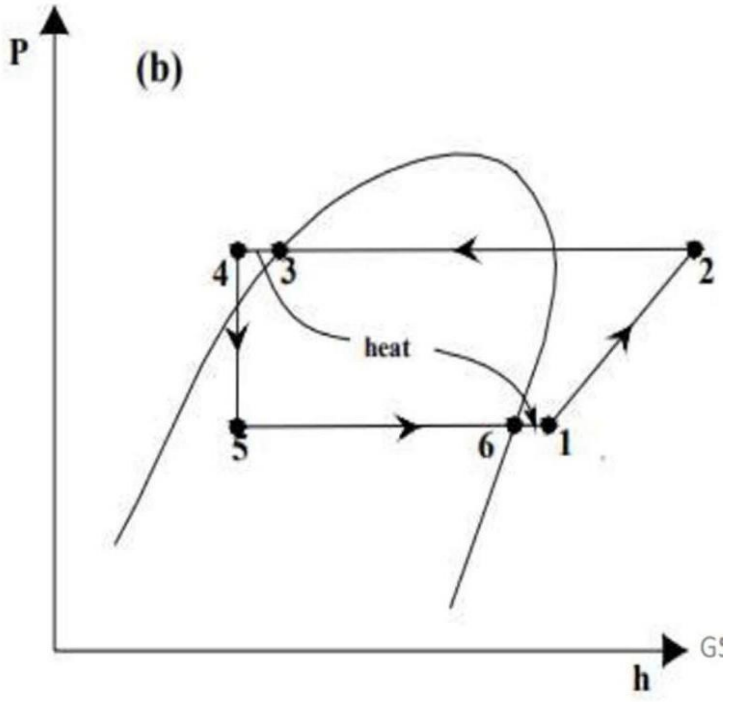
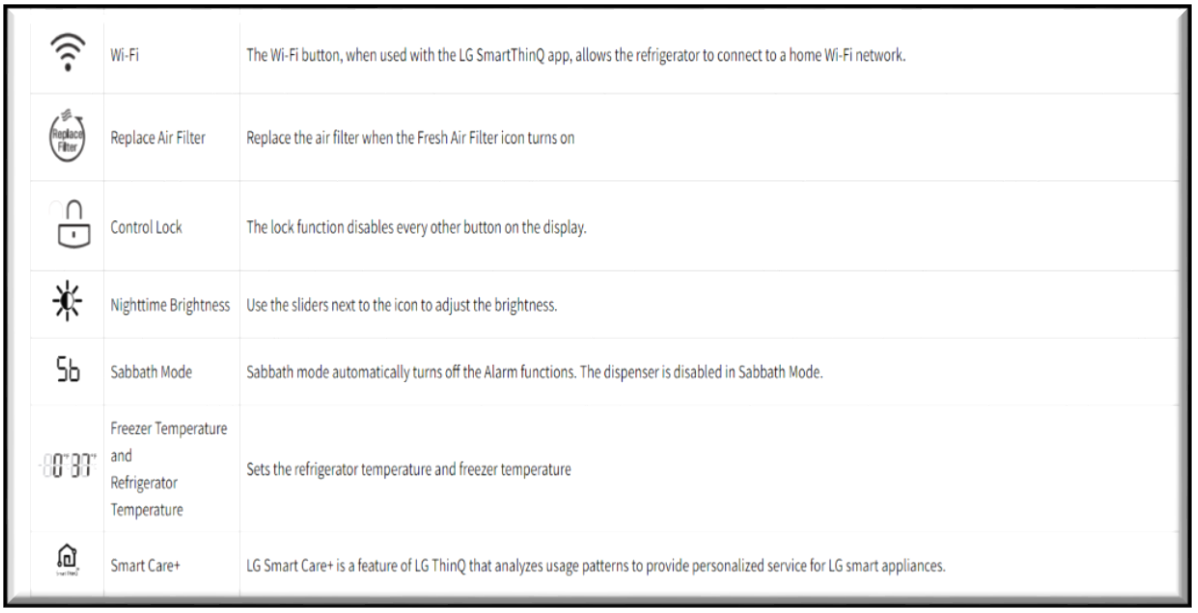


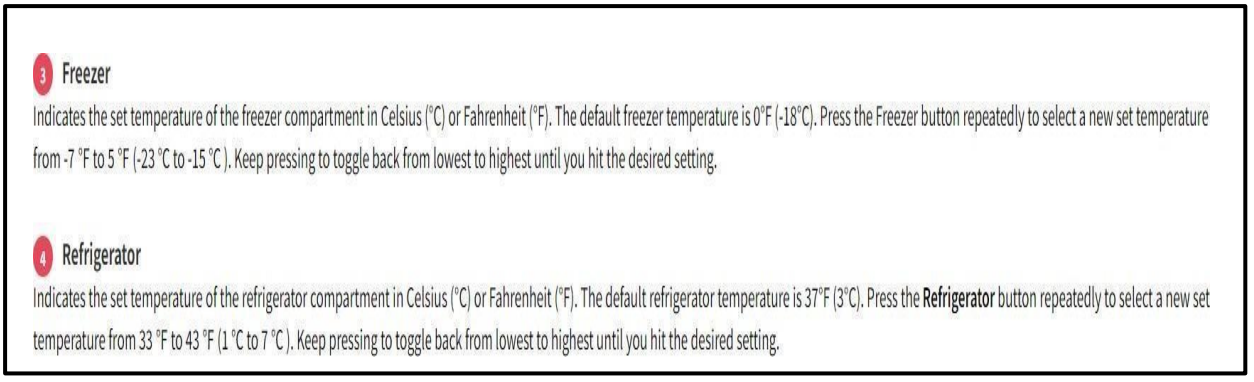
Figure 8.2 LSHX function through p-h diagram

Control Panel Icons

Icon	Feature	Signification
	Ice Plus	Function to increase ice making & freezing activated.
	Replace Water Filter	Indicates it is time to replace the water filter.
Grid	Smart Grid	The function automatically turns on when the refrigerator is connected to the Wi-Fi network. When the refrigerator is responding to a Demand Response (DR) message from the electric company, the Grid indicator illuminates.
	Wi-Fi	The Wi-Fi button, when used with the LG SmartThinQ app, allows the refrigerator to connect to a home Wi-Fi network.



	Wi-Fi	The Wi-Fi button, when used with the LG SmartThinQ app, allows the refrigerator to connect to a home Wi-Fi network.
	Replace Air Filter	Replace the air filter when the Fresh Air Filter icon turns on
	Control Lock	The lock function disables every other button on the display.
	Nighttime Brightness	Use the sliders next to the icon to adjust the brightness.
Sb	Sabbath Mode	Sabbath mode automatically turns off the Alarm functions. The dispenser is disabled in Sabbath Mode.
0°F 37°F	Freezer Temperature and Refrigerator Temperature	Sets the refrigerator temperature and freezer temperature
	Smart Care+	LG Smart Care+ is a feature of LG ThinQ that analyzes usage patterns to provide personalized service for LG smart appliances.



3 Freezer

Indicates the set temperature of the freezer compartment in Celsius (°C) or Fahrenheit (°F). The default freezer temperature is 0°F (-18°C). Press the Freezer button repeatedly to select a new set temperature from -7 °F to 5 °F (-23 °C to -15 °C). Keep pressing to toggle back from lowest to highest until you hit the desired setting.

4 Refrigerator

Indicates the set temperature of the refrigerator compartment in Celsius (°C) or Fahrenheit (°F). The default refrigerator temperature is 37°F (3°C). Press the **Refrigerator** button repeatedly to select a new set temperature from 33 °F to 43 °F (1 °C to 7 °C). Keep pressing to toggle back from lowest to highest until you hit the desired setting.

Fig. 8.2 (b) ThinQ Display Interface

CHAPTER-9

CONCLUSION & FUTURE SCOPE

9.1 Conclusion

In conclusion, the R&D Refrigerator Department internship at LG Electronics India Pvt. Ltd. has been incredibly helpful in offering a real-world understanding of the challenges associated with creating and innovating in the appliance sector. through active participation in all phases of the development process, including ideation, prototyping, and testing. I now have a thorough understanding of the innovative ideas and technical difficulties involved in developing state-of-the-art refrigerator department technology.

I had the chance to work with interdisciplinary teams, pick the brains of seasoned professionals, and apply theoretical knowledge to practical issues during the internship. My technical skills have improved, but this experience has also sharpened my ability to prioritize work in a fast-paced workplace, adjust to changing project requirements, and communicate clearly.

All in all, this internship has been a fruitful journey of learning and development, and I am appreciative of the chance to further refrigerator technology. I'm excited to use the information and abilities I gained from this training in my upcoming efforts to build new products and innovate existing ones.

9.2 Future Scope for ThinQ Display in Refrigerators

1. Enhanced User Interface and Experience:

- **Smart Integration**: Enhance the display's integration with other smart home devices, enabling seamless communication and control through a centralized system.

- **Customizable Interface**: Allow users to customize their display interfaces based on their preferences and usage patterns, providing a personalized experience.

- **Voice Control**: Incorporate advanced voice recognition technologies to allow users to control the refrigerator and access information hands-free.

2. Advanced Features and Functionalities:

- **AI and Machine Learning**: Implement AI to analyze usage patterns and suggest energy-saving tips, recipe suggestions, or alert users about expiring food items.
- **Health Monitoring**: Develop features that monitor the nutritional content of stored food, alert users about the best-before dates, and suggest meal plans based on available ingredients.
- **Energy Efficiency**: Continuously improve the energy efficiency of the display and other components, leveraging the ThinQ platform to optimize overall refrigerator performance.

3. Robust Testing and Quality Assurance:

- **Enhanced Testing Protocols**: Develop more sophisticated and comprehensive testing protocols to ensure durability and reliability under various environmental conditions.
- **Real-World Testing**: Conduct extensive real-world testing in diverse climates and usage scenarios to gather data and improve performance.
- **Feedback Loops**: Establish strong feedback mechanisms from users to continuously refine and improve the display technology.

4. Market Expansion and Adaptation:

- **Global Standards Compliance**: Ensure that the display meets the regulatory standards of various countries, facilitating global market penetration.
- **Localization**: Adapt the display interface to different languages and cultural contexts, enhancing its appeal to a wider audience.
- **Partnerships and Collaborations**: Form strategic partnerships with other technology companies to integrate new features and expand market reach.

5. Sustainability and Environmental Impact:

- **Eco-Friendly Materials**: Explore the use of sustainable and recyclable materials in the display's construction to reduce environmental impact.
- **Energy Harvesting**: Research and develop energy-harvesting technologies to power the display using ambient energy sources, further reducing the refrigerator's overall energy consumption.
- **Lifecycle Analysis**: Perform detailed lifecycle assessments to identify and minimize the environmental footprint of the display throughout its production, use, and disposal stages.

6. Technological Innovations:

- **Augmented Reality (AR)**: Integrate AR capabilities to provide interactive and immersive experiences, such as virtual cooking assistants or visual food inventory management.
- **5G Connectivity**: Utilize 5G technology to enhance the connectivity and responsiveness of the display, enabling real-time updates and remote-control capabilities.
- **Quantum Dot Technology**: Investigate the use of quantum dot technology to improve display brightness, color accuracy, and energy efficiency.

By focusing on these areas, LG Electronics can further enhance the capabilities and appeal of its ThinQ display for refrigerators, ensuring it remains at the forefront of innovation and meets the evolving needs of consumers.

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