FEDERAL UNIVERSITY OF TECHNOLOGY OWERRI P.M.B 1526 OWERRI, IMO STATE

A TECHNICAL REPORT ON

STUDENTS INDUSTRIAL WORK EXPERIENCE SCHEME (SIWES) 400 LEVEL

UNDERTAKEN AT

ABA POWER LIMITED ELECTRIC (APLE) COMPANY

2 GEOMETRIC POWER ROAD, OSISIOMA ABA, ABIA STATE, NIGERIA

WRITTEN BY

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20191156853

SUBMITTED TO

THE DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

SCHOOL OF ELECTRICAL SYSTEMS ENGINEERING AND TECHNOLOGY

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF

BACHELOR OF ENGINEERING (B. ENG) IN ELECTRICAL AND ELECTRONICS ENGINEERING

JUNE, 2024

DEDICATION

This work is dedicated to God, whose guidance, grace, and blessings have illuminated my path and granted me strength and wisdom throughout my journey. I am eternally grateful for His unwavering love and divine guidance.

Additionally, I dedicate this work to my parents, Mr. & Mrs. Robert Alum Uko whose unwavering support, encouragement, and belief in me have been a source of inspiration and motivation.

DECLARATION

I, Alumuko Maria Onyinyechi, a student of FEDERAL UNIVERSITY OF TECHNOLOGY, OWERRI, hereby declare that the concepts of this SIWES report are a true and accurate representation of my work ad experience during my Students' Work Experience Scheme (SIWES) at Aba Power Limited Electric Company.

I confirm that the information presented in this report is based on my personal observation tasks ad responsibilities performed during the specified period. Any external sources or material used in this report have been appropriately cited and acknowledged.

I further affirm that the opinions, conclusions and recommendations provided in this report are solely my own and are based in the knowledge ad understanding gained through my practical engagement at Aba Power Limited electric Company. I have made every effort to ensure the accuracy and authenticity of the information provide herein.

I understand the importance of academic integrity and attest that this report has not been submitted for any other purpose or assessment.

………………………… …………………………

Signed

ALUMUKO, MARIA ONYINYECHI

20191156853

ACKNOWLEDGEMENT

I extend my heartfelt gratitude to Aba Power Limited Electric for providing me with the opportunity to undergo my Industrial Training. Special thanks to my industry-based supervisor, Engr. Simeon Akpata whose guidance and mentorship significantly contributed to my learning and professional development. I am also grateful to all the staff members of the company for their support and cooperation throughout my internship, especially Engr. Ibiam Nnachi (Project Manager), Engr. Linus Ezema (System Planner), Engr. Oluwaseyi Adelakun (Design Engineer) and Engr. Juventus Osita (ECN 1 Injection Substation Officer).

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Finally, I would like to acknowledge my family, IT colleagues, and friends for their unwavering support and encouragement. Their encouragement and understanding have been a source of strength throughout this journey.

ABSTRACT

This report documents the practical experiences and technical knowledge gained during the Student Industrial Work Experience Scheme (SIWES) at Aba Power Limited Electric Company. The focus areas include the operational principles and components of both distribution and injection substations. In the distribution substation, the student learned about the functionality of transformers and the procedures for managing them. The injection substation segment involved understanding the materials in the switchyard, such as insulators, circuit breakers, and busbars. The student operated the feeder panel and its breaker mechanisms, gaining hands-on experience in this critical aspect of power distribution.

Additionally, the control room's role in monitoring and managing the power supply network was explored, along with the templates and forms used in injection substations for documentation and process standardization. The report details the Ring Main Unit (RMU) distribution network, highlighting its significance in ensuring a reliable power supply. Practical skills in supervising distribution substation projects were developed, alongside generating single-line diagrams (SLDs) and creating Bill of Engineering Measurement and Evaluation (BEME) documents.

The internship posed challenges such as transportation difficulties and a limited duration, which constrained the depth of engagement. Despite these obstacles, the student gained substantial practical insights and skills essential for a career in electrical and electronics engineering, particularly in the power distribution sector. This experience has provided a solid foundation for understanding complex electrical systems and project management in a real-world setting.

CHAPTER ONE

Introduction to SIWES

Students Industrial Work Experience Scheme (SIWES) is a Skills Training Program designed to prepare and expose Students of Universities, Polytechnics, Colleges of Technology, Colleges of Agriculture and Colleges of Education for the Industrial Work situation they are likely to meet after graduation. The Scheme affords Students the opportunity of familiarizing and exposing themselves handling equipment and machinery that are usually not available in their institutions.

Before the establishment of the Scheme, there was a growing concern that graduates of our Institutions of higher learning lacked adequate practical knowledge and that the theoretical education in Higher Institutions was not responsive to the needs of the Employers of Labor.

It is against this background that the Industrial Training Fund (ITF) initiated, designed and introduced SIWES Scheme in 1973 to acquaint Students with the skills of handling Industrial equipment and machinery.

The Industrial Training Fund (ITF) solely funded the Scheme during its formative years. However, due to finance constraints, the Fund withdrew from the Scheme in 1978. The Federal Government noting the significance of the skills training, handed the management of the Scheme to the National Universities Commission (NUC) and the National Board for Technical Education (NBTE) in 1979. In November 1984, management and implementation of the Scheme was again reverted to the ITF with the funding to be solely borne by the Federal Government.

Brief History of SIWES

SIWES was founded in 1973 by ITF (Industrial Training Funds) to address the problem of tertiary institution graduates' lack of appropriate skills for employment in Nigerian industries. The Students' Industrial Work Experience Scheme (SIWES) was founded to be a skill training programme to help expose and prepare students of universities, Polytechnics and colleges of education for the industrial work situation to be met after graduation.

This system facilitates the transfer from the classroom to the workplace and aids in the application of knowledge. The program allows students to become acquainted with and exposed to the experience required in handling and operating equipment and machinery that are typically not available at their schools.

Prior to the establishment of this scheme, there was a rising concern and trend among industrialists that graduates from higher education institutions lacked appropriate practical experience for employment. Students who entered Nigerian universities to study science and technology were not previously trained in the practical aspects of their chosen fields. As a result of their lack of work experience, they had difficulty finding work.

As a result, employers believed that theoretical education in higher education was unresponsive to the needs of labor employers. Thousands of Nigerians faced this difficulty till 1973. The fund's main motivation for establishing and designing the scheme in 1973/74 was launched against this context.

The ITF (Industrial Training Fund) organization decided to aid all interested Nigerian students and created the SIWES program. The federal government officially approved and presented it in 1974. During its early years, the scheme was entirely supported by the ITF, but as the financial commitment became too much for the fund, it withdrew in 1978. The National Universities Commission (NUC) and the National Board for Technical Education (NBTE) were given control of the scheme by the federal government in 1979. The federal government handed over supervision and implementation of the scheme to ITF in November 1984. It was taken over by the Industrial Training Fund (ITF) in July 1985, with the federal government bearing entire responsibility for funding.

Mission Statement

To set and control standards of excellence, effectiveness and offer direct training of Professionals, technicians, technologists and entrepreneurs to meet the human resource needs for rapid industrialization and sustainable economic development of Nigeria, by using best of breed training techniques and modern technology to produce highly motivated and competent products.

Vision Statement

To be the foremost human resource development institution in providing dynamic, need-based knowledge and quality-driven intervention for industrial skills development in Nigeria and one of the best in the World.

Aims and Objectives of SIWES

Specifically, the objectives of the Students Industrial Work Experience Scheme

(SIWES) are to:

- Provide Avenue for Students in Institutions of Higher Learning to acquire industrial skills and experience in their course of study.
- Prepare Students for the industrial work situation they are to meet after graduation.
- Expose Students to work methods and techniques in handling equipment and machinery that may not be available in their Institutions.
- Make the transition from school to the world of work easier, and enhance Students contacts for later job placement.
- Provide Students with an opportunity to apply their knowledge in real work situation thereby bridging the gap between theory and practice.
- Enlist and strengthen Employers involvement in the entire education process and prepare Students for employment after graduation.

Roles of Students in SIWES Program

- Active Learning and Skill Acquisition: Students engage in hands-on tasks and observe industry practices to apply theoretical knowledge and gain practical experience.
- Documentation and Reporting: Maintaining a detailed logbook and compiling a comprehensive report of their activities and learning outcomes.
- Adherence to Workplace Policies: Complying with the organization's rules, safety protocols, and ethical standards while demonstrating professionalism.
- Collaboration and Teamwork: Working effectively with colleagues and supervisors, contributing to team projects, and building professional relationships.
- Problem-Solving and Initiative: Applying critical thinking to solve real-world challenges, seeking feedback for continuous improvement, and demonstrating proactive behavior.

Relevance or Importance of SIWES to Electrical and Electronics Engineering

- Practical Application of Knowledge: SIWES provides Electrical and Electronics Engineering students with hands-on experience, allowing them to apply theoretical concepts to real-world problems, enhancing their technical skills and confidence.
- Industry-Academia Collaboration: The program fosters collaboration between educational institutions and industry, ensuring curricula are aligned with current industry standards and technologies, preparing students to meet job market demands.
- Professional Networking and Career Growth: SIWES helps students build professional networks, gain valuable industry insights, and improve their employability, making them more competitive in the job market.

CHAPTER TWO

Brief History of Aba Power Limited Electric Company

APLE is a pioneer private sector licensee of the Nigerian Electricity Regulatory Commission, NERC for electricity distribution in Nigeria. APLE is a special purpose vehicle of the Ab Integrated Power Project for distribution of electricity to consumers within its ring-fenced Aba metropolis. The company plays a key role in the multi-million US Dollar Aba Integrated Power Project (Aba IPP) Phase 1, being developed by the Geometric Power group.

APLE's mission is to build an efficient network to distribute power in Nigeria in line with the Electric Power Sector Reform Act. APLE obtained its distribution license from NERC in 2007, for the distribution of electricity to customers within the Aba metropolis, comprising of regulated small commercial and residential consumers who would receive power through rehabilitated existing distribution lines in the "ring-fenced" network leased by the company form the Government owned utility, Power Holding Company of Nigeria, PHCN.

Core Values

I – Inspired

S – Socially Responsible

P – Professional

I – Innovation

R – Reliable

D – Dynamic

Our Mission

To develop and invest in sustainable power projects tat make economic and environmental sense and have positive socio-economic impact within the community.

Our Vision

To be the premier power solutions provider in sub-Sahara Africa.

Organogram of the company

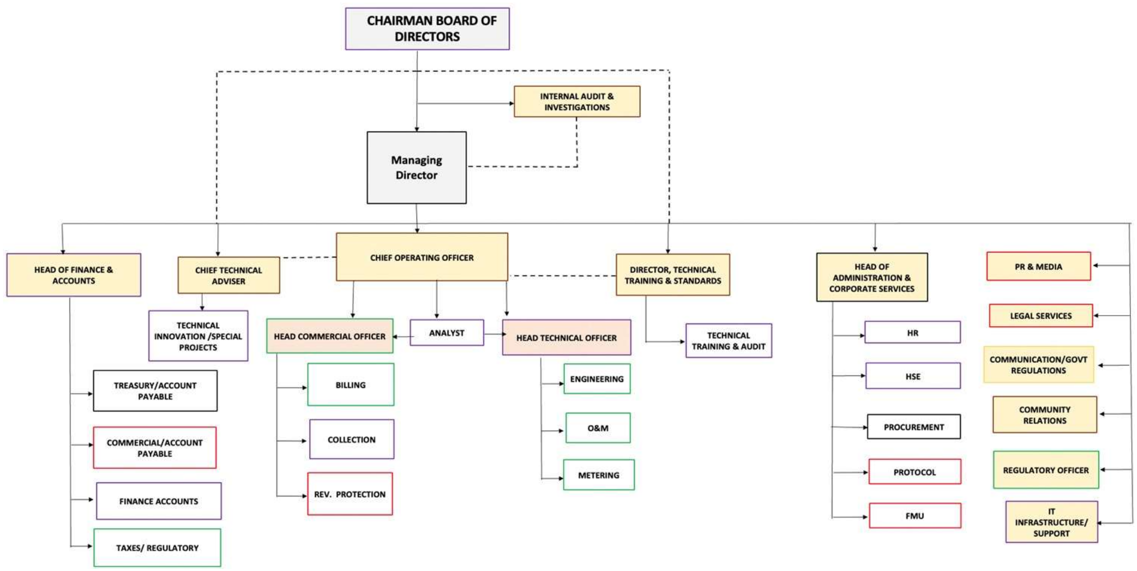

Fig. 1: Organogram of Aba Power Limited Electric Company

Products and Services of the Company

- Project Development and investment
- Power Generation
- Power Distribution and Metering

Safety Measures of the Company

1. Obtain or issue a valid work permit whenever required
2. Obtain authorization before you energize or disable electrical safety/ critical equipment
3. Never work on live electrical circuit and switch off all electrical appliances when not in use or at close of work
4. Never use inaccurate test equipment or instruments and follow the instructions manual and procedures.
5. Use appropriate personal protection equipment (PPE).
6. Do not work under suspended objects and do not manually lift heavy objects.

7. Protect yourself against a fall when working at a height using helmets and body harness.
8. Do not drive or use heavy/ electrical equipment after you have taken any tranquilizer or sedative
9. Do not smoke or drink while working.
10. Do not engage in any unsafe act or condition
11. You are responsible for your safety and the safety of others.
12. Safety first, safety always, safety my responsibility.

CHAPTER THREE

EXPERIENCES GAINED AT CLINTONEL INNOVATION CENTRE

Introduction to Computer-Aided Design (CAD)

Computer-aided design (CAD) is the use of computer software to assist with the design, layout, and technical documentation of products. CAD enables engineers to generate two-dimensional (2D) or three-dimensional (3D) models of an object or system of objects and view those models under a variety of different parameters to simulate and test real-world product conditions.

The purpose of CAD is to optimize and streamline the designer's workflow, increase productivity, improve the quality and level of detail in the design, improve documentation communications and often contribute toward a manufacturing design database. CAD software outputs come in the form of electronic files, which are then used accordingly for manufacturing processes.

CAD is often used in tandem with digitized manufacturing processes. CAD/CAM (computer-aided design/computer-aided manufacturing) is software used to design products such as electronic circuit boards in computers and other devices.

Who uses CAD?

Computer-aided design is used in a wide variety of professions. CAD software is used heavily within various architecture, arts and engineering projects. CAD use cases are specific to industry and job functions. Professions that use CAD tools include, but are not limited to:

- Architects
- Engineers
- City planners
- Graphic designers
- Animation illustrators
- Drafters

- Fashion designers
- Interior designers
- Exterior designers
- Game designers
- Product designers
- Industrial designers
- Manufacturers

CAD benefits

Compared to traditional technical sketching and manual drafting, the use of CAD design tools can have significant benefits for engineers and designers:

- Lower production costs for designs;
- Quicker project completion due to efficient workflow and design process;
- Changes can be made independent of other design details, without the need to completely re-do a sketch;
- Higher quality designs with documentation (such as angles, measurements, presets) built into the file;
- Clearer designs, better legibility and ease of interpretation by collaborators, as handmade drawings are not as clear or detailed;
- Use of digital files can make collaborating with colleagues simpler; and
- Software features can support generative design, solid modeling, and other technical functions.

CAD software/tools

A number of CAD tools exist to assist designers and engineers. Some CAD tools are tailored to fit specific use cases and industries, such as industrial design or architecture. Other CAD software tools can be used to support a variety of industries and project types. Some widely-used CAD tools are:

- MicroStation (offered by Bentley Systems)
- AutoCAD (offered by Autodesk)
- Fusion 360 (offered by Autodesk)
- CorelCAD
- IronCAD
- CADTalk
- SolidWorks
- Onshape
- Catia
- LibreCAD
- OpenSCAD
- Vectorworks
- Solid Edge
- Altium Designer

Applications of CAD in Electrical and Electronics Engineering

CAD technology is indispensable in electrical and electronics engineering for several applications:

- PCB Design and Layout: CAD software simplifies the design of PCBs, ensuring precision in the placement of components and routing of electrical connections.
- Circuit Simulation and Analysis: Tools within CAD software allow engineers to simulate electrical circuits to verify functionality and performance before physical prototyping.
- Electromechanical Integration: CAD software helps integrate mechanical and electrical components, crucial for devices like smartphones and robotics and also creating mechanical parts for electronic designs and enclosures for PCBs.

- Thermal Analysis and Management: Engineers can use CAD tools to perform thermal analysis, ensuring that electronic components remain within safe operating temperatures.

Overview of Fusion 360

Fusion 360 is a cloud-based 3D CAD, CAM, and CAE tool for product design and manufacturing, developed by Autodesk. It combines industrial and mechanical design, simulation, collaboration, electronics design and machining in a single package. Fusion 360 is known for its user-friendly interface, integrated features, and the ability to run on both Mac and PC platforms.

Key Features of Fusion 360

- 3D Modeling: Fusion 360 offers a comprehensive suite of tools for creating detailed 3D models. This includes parametric, freeform, and surface modeling capabilities.
- CAD/CAM Integration: It seamlessly integrates CAD and CAM, allowing users to design and then directly create the toolpaths for manufacturing.
- Simulation: Provides tools for performing finite element analysis (FEA), thermal analysis, and other simulation tasks to test the performance of designs.
- Collaborative Tools: Since it is cloud-based, Fusion 360 enables real-time collaboration with team members regardless of their location. It includes version control and allows multiple users to work on the same project.
- Data Management: Includes features for managing design data, including version history and tracking of changes.
- Generative Design: Uses AI-driven algorithms to explore multiple design options based on user-defined constraints and requirements.
- PCB design: It includes a workspace specially for designing complex PCB from capturing schematics, creating layouts, placing components, routing and generating 3D PCB models.

Installing Fusion 360

System Requirements:

Before installing Fusion 360, ensure your computer meets the minimum system requirements:

Operating System: Windows 10 (64-bit) or macOS 10.15 or later.

Processor: 64-bit processor with 4 cores.

RAM: 4 GB minimum (16 GB recommended).
Graphics: DirectX 11 capable card with 1 GB VRAM minimum.
Disk Space: 3 GB of free storage.

Installation Steps:

1. Create an Autodesk Account:

- Go to the [Autodesk website] (https://www.autodesk.com/products/fusion-360/overview).
- Sign up for an account or log in if you already have one.

2. Download Fusion 360:

- Navigate to the Fusion 360 product page.
- Select the appropriate version for your operating system.
- Click the download button.

3. Install Fusion 360:

- Once the download is complete, open the installer file.
- Follow the on-screen instructions to complete the installation process.
- Launch Fusion 360 and log in with your Autodesk account credentials.

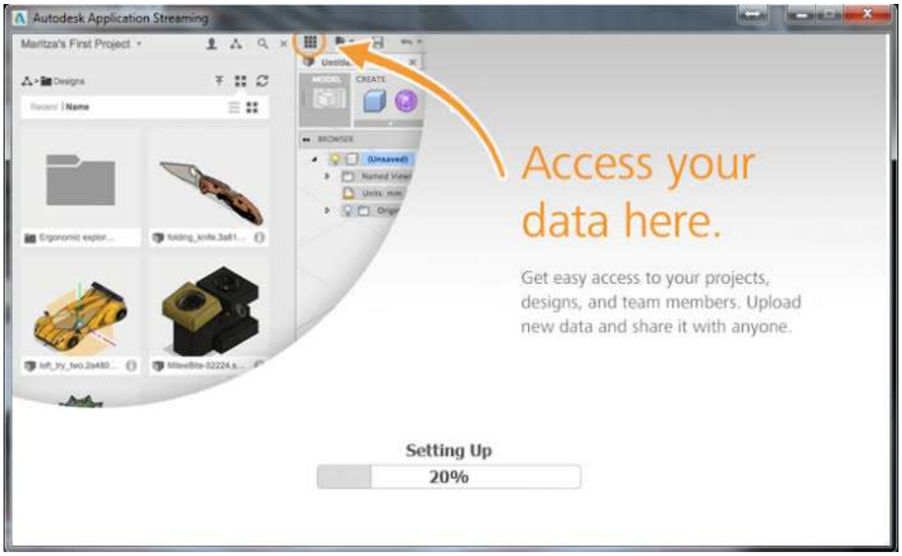

Fig. 2: Fusion 360 installation

Fusion 360 Workspace Overview

Fusion 360's workspace is designed to streamline the design, engineering, and manufacturing process. Here's a breakdown of its main components according to the numbering in Fig 3.

1. Application Bar

The Application Bar is located in the upper lefthand corner.

Within the application bar, there are 4 key areas.

- Data panel – houses your design files.
- File menu – create, export, or share your designs.
- Save – Save your designs along with version descriptions.
- Undo and Redo buttons – to revert your most recent actions.

Across the top, you'll see tabs that represent each design file. The file name and version number will be displayed on the tab.

2. Data Panel

The Data Panel houses all of your design files. Within the data panel, you can create new projects and folders, to further organize your files.

The data panel also allows you to manage other users who are collaborating on your projects, but note that there are restrictions based on which license type you're using.

3. Profile and Help

Notification Center – Notifications will appear (a few times a year) with important notices, such as planned maintenance.

Job Status – View job status, Fusion 360 update status, and online/offline status.

Profile – Click your name to:

Access your Autodesk Account

Adjust your Fusion 360 preferences

Switch between teams

View or edit your profile

Sign out

4. Toolbar

The toolbar allows you to select what type of workspace you would like to work in. It's important to note that the tools on the toolbar will differ in each workspace.

Within each toolbar, there are also tabs, which further organize the tools into logical groupings.

5. Browser

The browser lists objects in your design, including planes, sketches, parts, assemblies, and so on. You can think of the Browser as your file structure.

Within the browser, you can change the visibility of objects as well as change your document units.

6. View Cube

The view cube allows you to orbit your design or view the design from standard view positions. You can either select faces, corners, or the arrows, or you can simply click and drag the view cube around.

You can also hit the home icon, which is next to the view cube, to view the model in the default home position.

7. Canvas and Marking Menu

The middle section of Fusion 360 is where you'll be doing sketching and doing all of your design work. Therefore, this section is referred to as the canvas.

Within the canvas, you can access the "marking menu," which is also referred to as the right-click menu.

If you right-click you'll see frequently used commands, along with the ability to change workspaces, without having to go to the upper left corner.

8. Navigation Bar and Display Settings

The navigation bar contains commands used to zoom, pan, and orbit your design. These options will give you a little bit more control over the use of the view cube.

The display settings control the appearance of the interface. You can change the environment style (color), you can turn on and off ground shadows and other effects, turn grids on or off, or view your design from multiple views at once.

9. Timeline

The timeline lists the order of operations performed on your design. Double-click on timeline features to quickly edit their properties. You can also right-click operations to make additional changes.

Because Fusion 360 is a parametric modeling program, you can also drag the operations around to change the order they are calculated. However, you'll want to be very careful as changing the order can also cause errors or problems with your model.

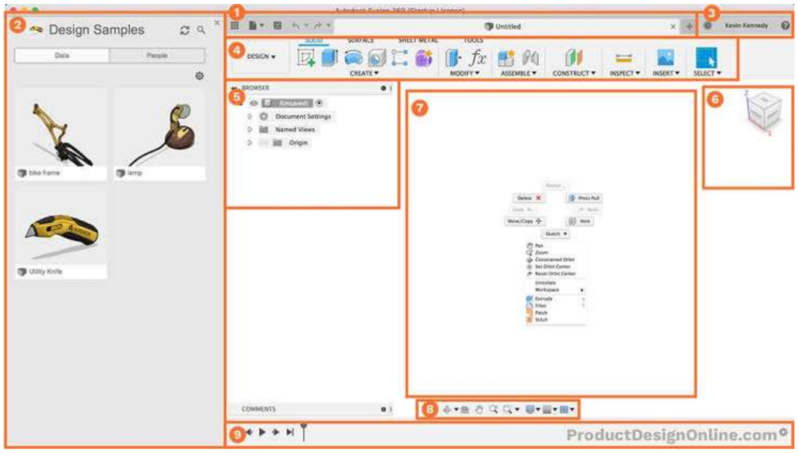

Fig 3: Fusion 360 workspace

Key Tools and Their Uses

Sketch Tools:

- Line: Draw straight lines. Essential for creating the basic shape of a part.
- Rectangle: Create rectangles and squares quickly.
- Circle: Draw circles by specifying the center point and radius.

Solid Tools:

- Extrude: Convert 2D sketches into 3D shapes by stretching them along a specified axis.
- Revolve: Create 3D objects by revolving a 2D sketch around an axis.
- Sweep: Generate a 3D shape by sweeping a 2D profile along a path.

Modify Tools:

- Fillet: Round off the edges of a model to remove sharp corners.
- Chamfer: Create a beveled edge along the intersection of two faces.
- Shell: Hollow out a solid body, leaving a specified wall thickness.

Assembly Tools:

- Joint: Connect components with precise relationships (e.g., rigid, rotational, slider).

- As-Built Joint: Create joints based on the current position of components without moving them.

Inspect Tools:

- Measure: Determine the distance, angle, or area between points or edges.
- Section Analysis: View cross-sections of your model to inspect the interior.

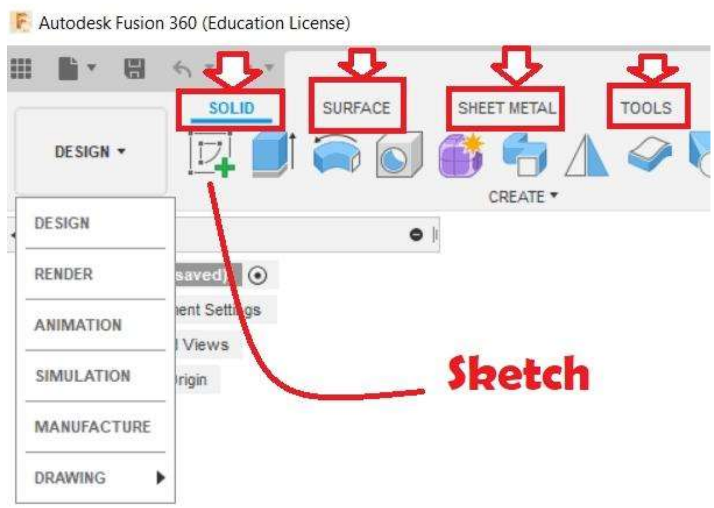

Fig. 4: Some of Fusion 360 key tools

Example of Workflow for making a simple 2D to 3D CAD design

Create a Sketch:

- Open the Design workspace.
- Select a plane and use the sketch tools (line, circle) to outline the basic shapes to form the 2D sketches as shown in fig. 5.

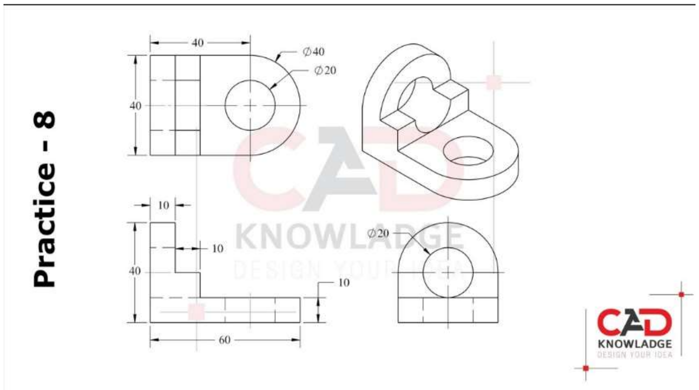

Fig. 5: The sketch

Create a 3D Model:

- Use the Extrude tool to turn your 2D sketch into a 3D object.
- Apply modifications like Fillet and Chamfer to refine the shape as done in fig. 6.

Assemble Components:

- Insert additional components if needed.
- Use the Joint tool to connect them.

Inspect and Analyze:

- Measure critical dimensions to ensure they meet specifications.
- Use Section Analysis to inspect internal features.

Finalize Design:

- Move to the Render workspace for photorealistic images.
- Use the Manufacture workspace to generate toolpaths for CNC machining.

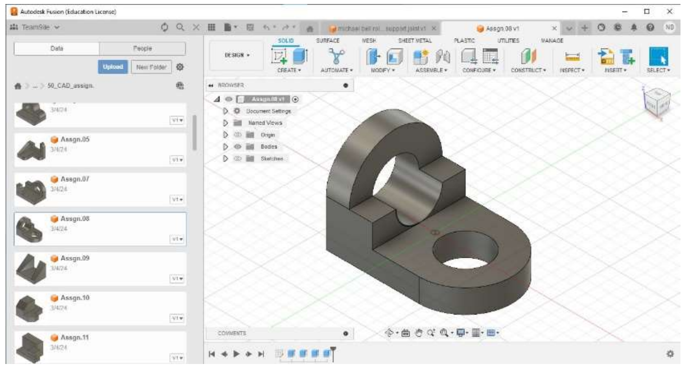

Fig. 6: The 3D CAD model

By mastering these tools and understanding the workspace, you can efficiently create, modify, and analyze complex designs in Fusion 360.

Advantages of Using Fusion 360 in Electrical and Electronics Engineering

The use of Fusion 360 in electrical and electronics engineering offers numerous advantages:

- Integrated Workflow: Combines design, simulation, and collaboration tools in one platform, streamlining the engineering process an reduces the need for multiple software.
- Enhanced Collaboration: Cloud-based features enable real-time collaboration, allowing team members to work together seamlessly on same projects from different locations.
- Improved Design Accuracy and Efficiency: Advanced modeling and simulation tools ensure high precision and reduce the likelihood of errors.
- Cost and Time Savings: Reduces the need for physical prototypes, saving time and resources.

Challenges and Limitations of Fusion 360

Despite its benefits, Fusion 360 also presents certain challenges:

- Learning Curve and Training Requirements: New users may require significant training to utilize the software effectively.

- Software and Hardware Requirements: Requires powerful hardware and a stable internet connection for optimal performance.
- Potential Integration Issues with Other Tools: Compatibility with other CAD tools and software can sometimes be an issue, necessitating additional effort for data migration and integration.

Fig. 7: Working on a 3D CAD model with Autodesk Fusion 360

STEM Kit project on Color Mixing using RGB LED as a Case Study

About the Project

An RGB LED Color Mixer is a compact and versatile lighting system designed for creative interactive color mixing. With the aid of potentiometers, users can manually adjust the intensity of the red, green and blue LEDs to create custom colors and lighting effect. It is powered with a battery which enhances its portability. The materials used for the design and production of the Color mixer are easily accessible and relatable to even the most basic Students of Engineering and related fields.

Fig. 8: An RGB LED Color Mixer

Color mixing discovery and formula

This is a contributive effort which began with Sir Isaac Newton in the 17th Century, when he conducted an experiment with prisms and observed that white light could be separated into a Spectrum of Colors.

In the 19th century, Thomas Young and Hermann Von Helmholtz brought about the understanding of color vision and trichromatic theory.

Then, in the 20th century, the likes of James Clerk Maxwell and John Logie Baird played significant roles in practical application of additive color mixing.

The Formula is:

Resulting Color = (Red Intensity * Red Component) + (Green Intensity * Green Component) + (Blue Intensity * Blue Component)

The Science of Colors (Relationship between Light and Color)

Light is made of wavelengths of light, and each wavelength is a particular color. Color we see is as a result of which wavelength is reflected back to our eyes.

We can simply put that Color is reflected Light.

Wavelength of light range from 700nm at red end of Spectrum to 400nm at Violet end (ROYGBIV).

Fig. 9: Color Mixing

The combination of all these wavelengths or that of the primary colors (Red, Blue and Green) give us white light (Additive Mixing).

White light is polychromatic, it reflects all light wavelengths.

While the removal of light or the combination of the secondary colors (Cyan, Magenta and Yellow) give us Black (Subtractive Mixing).

Practical application of Additive and Subtractive Color mixing

Addictive Color Mixing

- LED Screen Displays and Televisions
- Stage and Mood Lightings
- Photography and Video Editing

Subtractive Color Mixing

- Offset Printing
- Painting

How Students can verify the Project through experiments

- Color Mixing
- Lighting Effects
- Color Calibration
- Digital Signage

Specification of the Project model

- Bright Colored RGB LED Bulbs
- 430 ohms Resistor
- Cable Cores
- 3 10K ohms Potentiometer
- Rocker Switch
- 3.7V battery
- Frames (Plastic, Wooden or Carton)

Feasibility study of the Project

Technical:

- This Project contains RGB LED bulbs tested with a multimeter to ensure accurate color with intensity ranging from 0-255W. The LEDs are energy efficient as they use less than 75% energy and last up to 25 times longer than an incandescent bulb.

Cost:

- It is made up of cost-effective materials which can be easily accessed by students in case of personal home experiments.
- The Resistors, potentiometers and battery can be gotten for cheap prices at electronics shops.

Market:

- Due to its practical applications, there is high demand of this project to serve as teaching aid in schools. It is also needed by event planners for stage lighting, and home decors.
- The color mixer on its own is an aesthetically pleasing project, therefore attractive enough to lure students to use it. The potentiometer enables easy adjustment in order to get desired color mixtures. To enable the kind of resistor to be used, that can be calculated by obtaining the source and forward voltage of your led and choosing a desired current.

Financial:

- Since the materials for production are cost effective, color mixer can be made in large quantity and sold to schools and individuals who need it for its aesthetics.

Environmental and Regulatory:

- The plastic, glass and aluminum materials for manufacturing the Color Mixer are recyclable.

Summary of the Project

With the RGB LED Color Mixer, we believe in helping students gain better knowledge and understanding of Color and its related sciences. This project combines electrical knowledge, hardware and proper design thinking to provide a dynamic and customizable lighting experience. We intend to make STEM education more practicalized and reality based than illusional.

CHAPTER FOUR

EXPERIENCES GAINED AT ABA POWER LIMITED ELECTRIC COMPANY

Kinds of Distribution Substation Projects

- Survey of abandoned transformers of different types (1MVA, 50KVA, 100KVA) for its rehabilitation and reactivation
- Upgrade of lines (E.g.: 11kv to 33kv)
- Site Inspection for Installation of new transformers
- Inspection of vandalized Distribution Substations or DSS areas prone to vandalism
- Dualization of lines to feed new areas or sites

Steps involved in achieving a Distribution Substation Project

- Check out for technical feasibility of project: This includes inspecting the area or site for its proximity to vandalism, whether the DSS would be situated in an area void of vegetations. This is in order to reduce line faults and unnecessary tripping.
- Take down a Single Line Diagram (SLD) of the project: This has to do with line diagrams of the area under supervision. The drawing should include already existing DSS structures like lines, poles, transformers etc. This is to enable the Engineer and contractor in charge of the project know the necessary equipment needed to create a Bill of Engineering and Measurement Evaluation (BEME) for the project to be carried out.
- Prepare the Bill of Engineering and Measurement Evaluation (BEME): The BEME is a document which contains the type of material, quantity and quality to be used for an Engineering project with their unit prices attached. This document is prepared according to the information gotten from the Single Line Diagram. After preparation, it is taken to the head of engineering or Chief Technical Officer of the company for approval.
- Approval and Project award: After several consideration and inspection confirmation, the project is approved and awarded to the contractor in charge of the project. He is given a permit which would cover his work activities

throughout the period he works on the project. The Engineer on duty is mean to inspect the project till it is completed and commissioned.

- Metering: In order to control the amount of load on the installed transformer, it is metered by the company. This enables the company to take accurate energy readings off the transformer and have it under their check.

Fig. 10: 1x1 MVA, 33/0.400KV Transformer for Xiangjie Company's Power Distribution Substation

Fig. 11: Project Completion Inspection of 1x1 MVA, 33/0.400KV Power Distribution Substation for Xiangjie Company

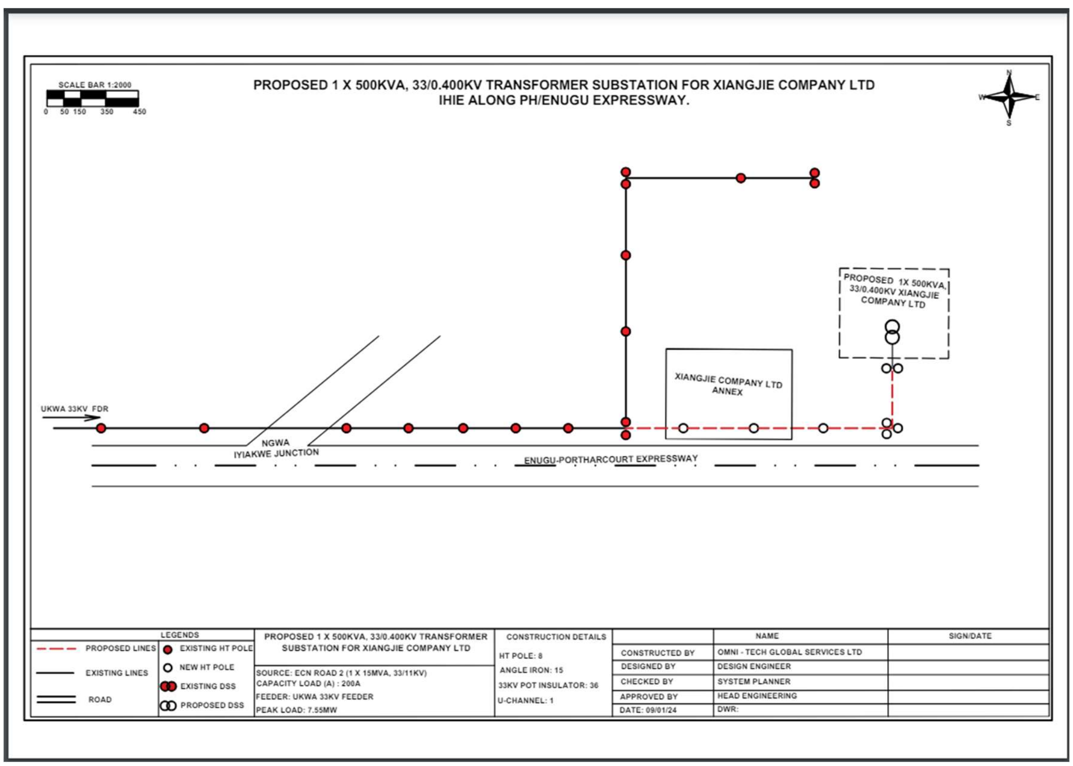

Fig. 12: Proposed 1x500KVA, 33/0.400KV Transformer Substation for Xiangjie Company

Introduction to Injection Substation

Working of an Injection Substation Switchyard:

The injection substation is where the source of distribution is taken from. They also function as the main distribution substation but on a larger scale. The switchyard contains all the necessary equipment to manage this process, including transformers, circuit breakers, isolators, busbars, and various protective and control devices. The process can be outlined as follows:

- Power Reception: High-voltage electricity enters the switchyard from the transmission lines through incoming feeders. These feeders connect to high-voltage isolators, which can disconnect parts of the network for maintenance or fault isolation without affecting the entire system.

- Voltage Transformation: Power transformers within the switchyard step down the high voltage (e.g., from 132kV to 33kV or from 33kV to 11kV). These transformers are equipped with on-load tap changers to adjust the voltage as needed to maintain stable output levels despite variations in load.

- Switching and Protection: Circuit breakers, located at various points in the switchyard, are essential for protecting the electrical system. They can automatically interrupt the flow of electricity in the event of a fault, such as a short circuit or overload, thereby preventing damage to equipment and ensuring safety.

Protective relays continuously monitor electrical parameters and, upon detecting abnormal conditions, trigger the circuit breakers to isolate the affected section of the network.

- Distribution: After voltage transformation and necessary switching operations, the electricity is routed through busbars and then to outgoing feeders. These feeders distribute the electricity to different parts of the network or directly to distribution transformers closer to end users.

Materials in the Switchyard:

- Marshalling Kiosk: The marshalling kiosk is a centralized cabinet where all control cables from various switchyard equipment converge. It houses terminal blocks, meters, relays, and control devices. The primary function of the marshalling kiosk is to organize and protect the control and communication wiring. It provides a convenient point for connecting and disconnecting control cables during maintenance and ensures that signals from different devices are correctly routed to the control room.
- Interconnection Bell or Gantry: The interconnection gantry is a structural framework that supports overhead conductors, connecting various parts of the switchyard. It serves as the primary support structure for the high-voltage lines entering and exiting the switchyard. The gantry ensures that conductors are held at a safe height above the ground and other equipment, preventing electrical hazards. It also provides physical separation between incoming and outgoing lines, reducing the risk of electrical faults and improving operational safety.
- Isolators (Disconnect Switches): Isolators are mechanical switches used to de-energize specific sections of the switchyard for maintenance or during fault conditions. They ensure that equipment can be safely isolated without disrupting the overall operation of the substation. Unlike circuit breakers, isolators do not interrupt load current but are used to ensure a circuit is completely open and safe to work on.
- Air-Break (AB) Switches: AB switches are used to interrupt the flow of electricity under load conditions. They operate in the open air, where an arc is drawn and extinguished when the switch opens. AB switches are essential for controlling the flow of power and for isolating faults within the switchyard.
- Pot Insulators (Post Insulators): Pot insulators provide insulation between live electrical components and grounded structures. They support and separate conductors, ensuring there is no unwanted current flow to the ground, which could cause operational issues or safety hazards.

- Busbars: Busbars are metallic strips or bars that conduct electricity within the switchyard. They serve as a common connection point for multiple circuits, allowing for the distribution of power to various outgoing feeders. Busbars are designed to carry large currents and are critical for the efficient operation of the substation.
- Lightning Arresters: Lightning arresters protect the switchyard equipment from lightning-induced voltage surges. They divert the high-voltage spikes to the ground, preventing damage to transformers, circuit breakers, and other critical components.

Fig. 13: Aba Control injection subjection Switchyard at ECN

- Earthing System: The earthing system includes earth rods, earth mats, and earthing conductors that provide a path for fault currents to dissipate safely into the ground. This system is crucial for the safety of the switchyard, protecting both equipment and personnel from electric shocks and ensuring stable operation.

- Transformers: Step down the high transmission voltage to a lower distribution voltage.
- Circuit Breakers: Protect the electrical system by interrupting fault currents.
- Lightning Arresters: Protect the system from lightning-induced surges.
- Current Transformers (CTs) and Potential Transformers (PTs): Measure current and voltage for metering and protection.

Introduction to Distribution Substation

In Nigeria, the process of electricity distribution involves a series of steps and components within the distribution substations that ensure power is efficiently and safely transferred from high-voltage transmission lines to end users. Here's a detailed narrative of how these substations operate, using components commonly found in Nigerian electrical infrastructure.

Electricity in Nigeria is generated at various power plants and transmitted over long distances at high voltages, typically ranging from 132kV to 330kV, to minimize energy losses. When this high-voltage electricity reaches a distribution substation, it enters through transmission lines and is first handled by power transformers. These transformers step down the high voltage to a lower voltage suitable for distribution, commonly 33kV or 11kV.

Within the substation, several key components work together to manage and distribute this electricity. First, isolators or disconnect switches are used to isolate sections of the electrical network for maintenance or fault conditions. These mechanical switches ensure that electrical equipment can be safely de-energized for inspections or repairs.

Air-break (AB) switches are also prevalent in Nigerian substations. These switches operate in the open air and are used to interrupt the flow of electricity under load conditions. When an AB switch opens, an arc is drawn in the air, which is then extinguished, allowing the switch to safely control electrical circuits. These switches are essential for controlling the flow of power and for isolating faults within the network.

Pot insulators, or post insulators, provide critical insulation between live electrical components and the grounded structures of the substation. They support and separate conductors, preventing unwanted current flow to the ground, which could cause short circuits or other operational issues.

Voltage regulation within the substation is managed by on-load tap changers on the transformers. These devices adjust the transformer's turns ratio to maintain the desired output voltage despite variations in load demand. Additional voltage regulation equipment, such as capacitor banks and reactors, helps manage reactive power and maintain power quality, ensuring stable and efficient operation.

Protective devices are crucial for the safe operation of the substation. Protective relays continuously monitor electrical parameters such as current, voltage, and frequency. If an abnormal condition like an overcurrent or fault is detected, the relay triggers circuit breakers to disconnect the affected section. This action prevents damage to equipment and maintains the stability of the network. Circuit breakers and fuses in feeder pillars also play a critical role in protecting downstream distribution circuits.

Once the voltage is regulated and protection mechanisms are in place, electricity is distributed from the substation to various feeders. Each feeder is equipped with its own protective devices and switches, allowing for localized control and protection. In the Nigerian context, distribution lines from these feeders carry electricity to distribution transformers closer to end users. These local transformers further step down the voltage to levels suitable for residential or commercial use, typically 240V or 415V.

Throughout the distribution network, materials such as H-poles and cross arms provide physical support for conductors. H-poles, often made of treated wood or concrete, are a common sight in Nigerian distribution networks. They support cross arms that hold the conductors and ensure proper spacing and stability.

Finally, electricity reaches consumers through service drops, which connect distribution lines to individual homes, businesses, and industrial facilities. Each service drop includes protective devices like fuses and circuit breakers to safeguard against faults and ensure safe delivery of electrical power.

Materials found in a Distribution Substation

1. H-Pole

Definition: An H-pole is a type of structure used to support electrical conductors. It consists of two vertical poles connected by a horizontal crossbar, forming an 'H' shape.

Function:

- Provides support for electrical conductors and equipment.
- Commonly used in overhead distribution systems.

Materials: Typically made of wood, steel, or reinforced concrete.

2. Disc Insulators

Definition: Disc insulators are used to isolate and support electrical conductors at high voltages.

Function:

- Prevent electrical leakage to the pole.
- The number of discs depends on the voltage level.

Materials: Made from glass, porcelain, or composite materials.

3. Cross Arms

Definition: Cross arms are horizontal members attached to poles to support electrical conductors.

Types:

- Angle/Channel Irons: Made of galvanized steel for strength and durability.
- Wooden Cross Arms: Made of treated wood, offering insulation properties.
- Fiber Cross Arms: Made from fiberglass-reinforced plastic, combining strength with electrical insulation.

Function:

- Provide structural support for conductors and insulators.

- Help maintain the proper spacing between conductors.

4. Distribution Transformer

Definition: A distribution transformer steps down the high voltage from the primary distribution line to a lower voltage suitable for end users.

Specifications:

- KVA Rating: Determines the capacity of the transformer.
- Voltage Levels: Common ratings are 33/0.415kV and 11/0.415kV.

Function:

- Converts high-voltage electricity to low voltage for distribution to homes and businesses.

Materials: Typically made of copper or aluminium windings with an oil-filled or dry-type core.

5. Drop-Fuse (D-Fuse)

Definition: A drop-fuse, or dropout fuse, is a protective device used in medium voltage networks.

Function:

- Protects the distribution system from overcurrent and short circuits by breaking the circuit when a fault occurs.

Specifications:

- Rated for voltages such as 11kV, 33kV, and 6.6kV.

Materials: Consists of a fuse element housed in a porcelain or fiberglass tube.

6. Gang Isolator Switch

Definition: A gang isolator switch is a mechanical switch that isolates a section of the distribution network.

Function:

- Allows for the disconnection of electrical equipment for maintenance or in case of faults.

Specifications:

- Common voltage ratings are 11kV and 33kV.

Materials: Made of galvanized steel with insulating components.

7. Lightning Arrester

Definition: A lightning arrester protects electrical equipment from voltage surges due to lightning strikes.

Function:

- Diverts the surge to the ground, preventing damage to the equipment.

Specifications:

- Rated for 11kV and 33kV systems.

Materials: Typically made of metal oxide or silicon carbide.

8. Earthing System

Definition: An earthing system connects electrical equipment to the ground to ensure safety.

Components:

- Earth Wires: Conductors that connect equipment to the ground.
- Earth Rods: Metal rods driven into the ground to provide a low-resistance path.

Function:

- Provides a safe path for fault currents to prevent electrical shock and equipment damage.

Materials: Made from copper or galvanized steel.

9. Feeder Pillar Fuse Box

Definition: A feeder pillar fuse box houses fuses and other protective devices for distribution circuits.

Function:

- Protects and distributes electrical power to various circuits.
- Ensures the safe operation of the distribution network.

Materials: Typically made of metal or fiberglass for durability and protection.

10. Line Fuse (J&P Fuse)

Definition: A J&P fuse (James & Parker fuse) is a type of high voltage fuse used for protecting overhead lines.

Function:

- Protects the line from overcurrent and short circuit conditions.

Materials: Consists of a fuse element in a ceramic or fiberglass tube.

11. 4 Core Armoured Cables (Risers)

Definition: Armoured cables with four conductors used for vertical connections in distribution systems.

Function:

- Provide robust and protected connections between equipment.

Materials: Made from copper or aluminium conductors with steel wire armouring for protection.

12. 1 Core Armoured Cables

Definition: Single-core armoured cables used for incoming or intermediate connections.

Function:

- Used for high-current connections in the distribution network.

Materials: Made from copper or aluminium conductors with steel wire armouring.

13. Bolts and Nuts

Definition: Bolts and nuts are fasteners used to secure components in the substation.

Function:

- Ensure mechanical stability and secure connections of various components.
- Materials: Typically made from galvanized steel or stainless steel to prevent corrosion.

Fig. 14: 2.5MVA, 33/11KV Distribution Substation under construction

Distribution Substation Transformer and its workings

Distribution transformer consist of a core, primary and secondary winding. Each enclose each other in a tank filled with insulating oil. The core and winding are responsible for voltage transformation dot. The oil serves as coolant and insulating material with excess oil is stored in the reservoir. There are also the cooling fins which cools the transformer.

The Transformer contains the Buchholz chamber or relay which protects transformer from faults occurring inside the transformer. It checks Buchholz reaction. When fault occurs inside the transformer, there is heat convention or heat produced by fault currents, this causes decomposition of transformer oil and gas bubbles are produced. Buchholz relay traps the bubbles which displaces the oil in the relay. This displacement causes the upper float to close the upper mercury switch connected to alarm circuit which gets activated due to fault. This Buchholz chamber is usually for bigger transformers.

Another part of the transformer is the name plate which contains every information about the transformer, the temperature gauge which contains the pointer and maximum drag pointer for checking the operating temperature of the transformer. We also have the silica gel which absorbs moisture than can damage the transformer when left.

Some distribution transformers have tap changers to adjust the output voltage. Transformer on the ground is referred to as Pad mounted transformer, while the other is the Pole mounted transformer. The Lightening arresters on the substation gantry keep transformers safe from lightening strikes by guiding the Lightening's energy away the V-shaped crossarm attached to the pole supports the electrical insulator and conductor (The Pin Insulator or Pot which differs by different line voltages).

Distribution transformer generally transform high voltage levels to low voltage levels through its primary and secondary bushings which are also known as high voltage and low voltage bushings respectively. The primary bushing is usually bigger than the secondary bushing. The high voltage wires are linked to the AB (Air break) switch which are installed outdoor for isolation or disconnection of electrical system. They are connected to the Fuse (Horn-gap fuse). This connection extends to the High tension or primary bushing of the transformer. Facing the source of supply, the first phase of the primary feeder from the left-hand side is Red – yellow – Blue of the primary bushing, with the incomer bar (Red – Yellow – Blue – Neutral) from the secondary bushing sending current to the control panels or feeder pillars. These go into the low-tension current transformer box (Low tension distribution box) with output cable transmitted to city or village.

Fig. 15: Osisioma Injection Substation 15MVA, 33/11KV Distribution transformer

The Distribution Network (The Ring main Unit)

There are two types of Distribution network

- The Radial (tree) type distribution: This is most commonly used in rural areas, very cheap and easy to install. But it is not very reliable, if anything happens to its feeder, the whole load won't receive power.
- Ring Main (Loop type) Network: it contains two feeders. The loads in this network get power from each of the feeders. If one feeder has issue, the other can feed the loads. It is more secure and reliable.

The Ring main Unit is a combination of switches that open or close the feeders and circuit breaker that protects the transformer. It is a switchgear which combines multiple switching functions and also provides protection to transformers. Its compactness varies based on voltage rating.

It can be called Single function RMU when it functions only for transformer protection.

Color codes for Transmission Network/ Distribution Substation Lines

- 330KV lines – Yellow
- 132KV lines – Black
- 33KV lines – Green
- 11KV lines – Red
- 6.6KV lines – Blue

Introduction to a Distribution Substation Control room

The control room in a distribution substation is the hub for monitoring and managing the electrical network. It houses various control and monitoring equipment that ensure the efficient and safe operation of the substation. The Distribution Substation Officer or Engineer on duty never leaves his work post for any reason as fault or emergency may occur in his absence. Hourly readings are taken from the relay mirrors on the panels and converted to megawatts with a dividing factor of 60, 100 and 20 for 11KV, 6.6KV and 33KV feeders respectively. The transmission operators get the readings hourly in megawatts. Every activity is being documented properly for reference purposes.

Materials found in the control room

Control Panels: House the control and protection devices, providing a centralized point for operating the substation.

Meters and Indicators: Measure electrical parameters such as voltage, current, frequency, and power.

Protective Relays: Detect abnormal conditions (e.g., overcurrent, overvoltage, underfrequency) and initiate the operation of circuit breakers.

2. Communication Equipment

Modems and Routers:

- Function: Provide communication links between the control room and remote locations.
- Types: Fiber optic modems, wireless routers, and Ethernet switches.

Telecommunication Equipment: Facilitate voice and data communication.

3. Power Supply Systems

Uninterruptible Power Supplies (UPS): Provide backup power to critical control and monitoring equipment during power outages.

Auxiliary Power Supplies (DC and AC): Supply power to control and communication equipment.

Battery Banks: Provide a reliable power source for control and protection systems.

4. Safety and Security Equipment

Fire Protection Systems (Fire extinguisher): Helps to protect personnel and equipment by putting off fire during a outbreak.

Surveillance Cameras: Monitor the control room and surrounding areas for security purposes.

Emergency Lighting: Provide illumination during power outages or emergencies.

5. Data Management Systems

Database Servers: Store large volumes of data collected from the substation.

Workstations and PCs: Provide user interfaces for monitoring, control, and data analysis.

6. Environmental Control Equipment

HVAC Systems (Heating, Ventilation, and Air Conditioning): Maintain a controlled environment to ensure the proper functioning of electronic equipment.

7. Miscellaneous Tools and Accessories

Test Equipment: Used for maintenance and troubleshooting.

Spare Parts and Consumables: Ensure quick replacement and repair of faulty components.

Documentation and Manuals: Provide guidelines and reference material for operating and maintaining the substation.

Workbenches and Storage: Provide space and organization for tools and spare parts.

Fig. 16: Osisioma Injection Substation Control Room

The principle of operation of a Feeder panel

A feeder panel is an essential component in the electrical distribution network, designed to manage and protect the distribution of electricity from the main supply to various branch circuits. It serves as a central hub where incoming electrical power is divided into subsidiary circuits, each protected by a fuse or circuit breaker. The transformers are controlled from its panels. The circuit breakers in the panels can be operated through electrical, manual or remote control with the electrical as the most commonly used.

ECN 1 has five outgoing 33KV feeders which are located in the switch yard, they are:

- Ukwa (33KV main and 33KV sub)
- Aba Owerri 33KV
- Aba Overhead 33KV
- Aba Umuahia 33KV
- IGI 33KV

They also control five outgoing feeders located in the control room, four 11KV feeders and one 6.6KV feeder, they are:

- Port Harcourt Road 1 11Kv feeder
- Omuma Road 1 11Kv feeder
- Ngwa Road 1 11Kv feeder
- Obohia Road 1 11Kv feeder
- Ehi Road 6.6KV feeder (This 132/6.6KV feeder has its dedicated transformer which is rare)

The primary functions of a feeder panel include:

1. Distribution: Directing electrical power from the main source to various branch circuits.

2. Protection: Safeguarding electrical circuits from overcurrent, short circuits, and other electrical faults through protective devices.

3. Control: Allowing for the isolation and control of individual circuits for maintenance and safety purposes.

Operating Principles and Mechanisms:

The operation of a feeder panel involves several key components and mechanisms, which work together to ensure safe and efficient distribution and protection of electrical power:

1. Main Circuit Breaker: The main circuit breaker is the primary protective device in a feeder panel. It controls the overall supply of electricity to the panel and protects the entire system from overcurrent conditions. When an excessive current is detected, the breaker trips, disconnecting the power supply and preventing potential damage. The main circuit breaker is crucial for ensuring the safety and reliability of the entire electrical system.

2. Busbars: Inside the feeder panel, busbars are used to distribute electrical power to various branch circuits. These metallic strips or bars conduct electricity from the main breaker to individual circuit breakers or fuses. Busbars are designed to

carry large currents and are typically made of copper or aluminium. They provide a reliable and efficient means of distributing power within the panel.

3. Individual Circuit Breakers/Fuses: Each branch circuit in the feeder panel is equipped with its own circuit breaker or fuse. These protective devices monitor the current flow in their respective circuits. In the event of an overcurrent or short circuit, they trip (in the case of breakers) or blow (in the case of fuses), interrupting the electrical flow and protecting the wiring and connected equipment. Circuit breakers can be manually reset after tripping, whereas fuses need to be replaced once they blow.

4. Control Devices: Feeder panels often include additional control devices such as switches and relays. These devices allow for manual or automatic control of specific circuits, enabling operations like turning circuits on or off for maintenance or in response to certain conditions. Relays can also provide automated control based on preset conditions, enhancing the functionality and flexibility of the feeder panel.

5. Monitoring Equipment: Advanced feeder panels may incorporate monitoring equipment such as ammeters, voltmeters, and power meters. These devices provide real-time data on the electrical parameters of the circuits, helping in monitoring and managing the electrical load effectively. Monitoring equipment is essential for maintaining the health and efficiency of the electrical system by providing valuable insights into its operation.

6. Terminal Blocks: Terminal blocks are used for organizing and connecting the various electrical wires within the feeder panel. They provide a secure and accessible means of connecting incoming and outgoing wires, making it easier to manage the complex network of connections within the panel. Terminal blocks also simplify maintenance and troubleshooting by providing clear and organized connection points.

7. Annunciators: Annunciators are devices that provide visual and audible alerts in case of faults or abnormal conditions in the electrical system. They help operators quickly identify and respond to issues, ensuring prompt action to

mitigate potential problems. Annunciators are critical for maintaining the safety and reliability of the electrical system by providing timely warnings.

8. Spring Charging Mechanism: The spring charging mechanism in circuit breakers ensures that the breaker is ready to operate at any moment. It charges a spring that provides the mechanical force needed to open or close the breaker contacts. This mechanism allows for quick and reliable operation of the breaker, ensuring that it can respond promptly to fault conditions.

Fig. 17: Spring – charging Ngwa Road 1 11KV Feeder's Circuit Breaker

9. Racking Mechanism: The racking mechanism allows for the safe insertion and removal of circuit breakers from the feeder panel. This mechanism enables breakers to be moved into and out of their operating positions without the need for direct manual handling, reducing the risk of electrical shock and making maintenance tasks safer and more efficient.

10. Bus Coupler: This connects multiple busbars at a time simultaneously. It enables transfer of load from a faulty transformer to a functioning one till the fault is rectified. The new transformer now has its lines load – shedded to avoid an overload.

Types of faults and how to rectify them

Electrical faults are any abnormal conditions that occur in an electrical system, disrupting the normal flow of current and potentially causing damage to equipment, loss of power, and safety hazards. When a fault occurs, it automatically trips off the line from the feeder panel. After several trials from the DSO on duty, the system control is notified and the line is declared faulty and ready to be patrolled. It is totally de-energized by racking out its circuit breaker and tagged to prevent operation till it is fully restored and linesmen return their permits and sign out. In some cases, the linesmen can consider sectionalization when fault persists.

1. Short Circuit Faults

Causes:

- Equipment Failure: Breakdowns in electrical equipment, such as transformers, motors, or generators, can cause short circuits.
- Insulation Breakdown: Deterioration or damage to the insulating material surrounding conductors can lead to direct contact between conductors, causing a short circuit.

Effects:

- High Current Flow: Short circuits result in a significant increase in current flow, which can cause severe heating and potential damage to conductors and connected equipment.
- Potential Equipment Damage: The intense heat generated can damage insulation, deform conductors, and destroy components like circuit breakers and transformers.

Rectification:

- Use of Protective Devices: Circuit breakers, fuses, and relays are essential for detecting and interrupting short circuits to protect the system.

- Proper Maintenance: Regular inspection and maintenance of equipment and insulation can prevent short circuits by identifying and addressing potential issues before they cause faults.

2. Open Circuit Faults

Causes:

- Conductor Breakage: Physical damage to conductors due to external forces, such as storms, falling trees, or construction activities, can cause open circuits.
- Loose Connections: Over time, connections can become loose due to vibration, thermal expansion, or poor installation practices.

Effects:

- Loss of Continuity: Open circuits result in a loss of continuity in the electrical path, leading to interruptions in power supply.
- Power Outages: Equipment and loads connected downstream of the open circuit will experience power outages.

Rectification:

- Inspect and Repair Connections: Regular inspection and maintenance of connections can identify and rectify loose or damaged connections.
- Replace Damaged Conductors: Identifying and replacing damaged or broken conductors promptly restores the continuity of the electrical circuit.

3. Earth Faults

Causes:

- Insulation Failure: Breakdown of insulation can lead to conductors coming into contact with the ground.
- Direct Contact with Ground: Accidental contact between live conductors and the ground, such as through fallen power lines or damaged equipment, can cause earth faults.

Effects:

- Ground Currents: Earth faults result in current flowing directly to the ground, which can cause localized heating and potential fire hazards.
- Potential Hazards: Ground currents can pose severe hazards to both people and equipment, including electric shock risks and damage to grounding systems.

Rectification:

- Use of Grounding Systems: Proper grounding systems ensure that fault currents are safely dissipated into the earth, minimizing risks.
- Insulation Testing: Regular testing of insulation helps detect and address potential weaknesses before they result in earth faults.

4. Overload Faults

Causes:

- Excessive Load Demand: Connecting too many devices or loads to a circuit can cause the current to exceed the circuit's capacity, leading to an overload fault.

Effects:

- Overheating: Overloaded circuits generate excessive heat, which can damage insulation, conductors, and connected equipment.
- Potential Damage to Equipment: Continuous overloading can lead to equipment failure, reducing the lifespan and reliability of electrical components.

Rectification:

- Load Management: Properly managing and balancing the load across circuits helps prevent overloading.
- Use of Circuit Breakers: Installing appropriately rated circuit breakers ensures that circuits are automatically disconnected when an overload condition is detected, preventing damage and hazards.

Templates used in an Injection Substation

1) General Realtime: This shows the status of all the feeders in every hour. It is made up of the name of the Disco, its Injection Substation, Source and Feeder code.
2) Outage Template: This is used to record tripping or outages on all outgoing feeders. It is made up of the Nature of outages, Relay Indicators, Occasion/ Cause of outage, Weather and Restoration.

   Nature of Outage includes:

   - OSD – Opportunity Shutdown
   - UPSD – Unplanned Shutdown
   - CSD – Customer Shutdown
   - EM – Emergency
   - IT – Inter tripping
   - SLS – Source Load Shedding
   - TP – Transmission problem
   - SFT – Source fault
   - FT – Fault
   - SPSD – Source Planned Shut Down
   - PSD – Planned Shut Down
   - ET – Equipment Limitation
   - LS – Load Shedding

   Relay Indicator:

   - O/C – Overcurrent
   - E/F – Earth Fault
   - O/C & E/F – Overcurrent/ Earth Fault
   - Inst. O/C – Instantaneous Overcurrent
   - Inst. E/F – Instantaneous Earth Fault
   - Inst. O/C & E/F – Instantaneous Overcurrent & Earth Fault

   Occasion Include:

   - VA – Vehicle Accident

- PB – Broken Poles
- LAF – Lightening Arrestor Failure
- WC – Wire Cut
- JC – Jumper Cut
- TR – Trees (Vegetations)
- PF – Pot Insulator Failure
- Imb – Phase Imbalance
- XF – Cross arm Failure
- DF – Disc Failure

Weather Include:

- N – Normal
- W – Windy
- R – Rainy

Restoration Include:

- F – Full Restoration of a feeder
- P – Partial Restoration of a feeder

3) 11KV Feeders Energy Reading: This is used to take down energy readings of the different feeders, by 12 midnight. To get energy consumed for the day, you delete the present from the previous day energy reading. It is made up of the name of the Disco company, Injection Substation, Feeder code, 11KV feeders and days of the week.
4) ECN ISS DSO's Monthly Returns: This is used for calculating and recording daily peak loads of feeders and transformer incomes.

Types of forms used at the Injection Substation

- OF. 4 – Permit issued to Linesmen for work.
- OF. 1 – Permit brought by Linesmen for work.
- OF. 56 – Logbook where every record or activity is recorded.
- OF. 8 – Tag for permit.
- Ledger – Sheet for taking hourly readings.

CHAPTER FIVE

Challenges Encountered:

- Transportation: One of the challenges faced during the internship was transportation. The stipends offered by the company are most times not enough to cover for one's basic expenses especially transportation.
- Short Period of Time for Internship: The relatively short duration of the internship posed a challenge in fully immersing oneself in the work environment and gaining comprehensive hands-on experience. The limited timeframe restricted the depth of involvement in projects and activities.
- Lack of Proper Information: Another significant challenge was the lack of proper information on various aspects of the field. Inadequate access to comprehensive resources and guidance hindered the understanding and execution of certain tasks, impacting overall learning and performance.
- Gender Biases: Gender biases were evident in certain instances, affecting opportunities for involvement in certain projects or activities. This challenge highlighted the need for equal opportunities and recognition based on merit rather than gender.

Conclusion

Despite the encountered challenges, the Industrial Training experience at Aba Power Limited Electric provided me with invaluable opportunities for learning, growth, and professional development. The exposure to real-world scenarios and practical applications of theoretical knowledge enhanced my skills and competencies, contributing to my personal and academic development.

Recommendations

- Extended Internship Period: There is a need for an extended internship period to allow for deeper immersion in the work environment and more substantial contributions to projects. This would enhance the overall learning experience and facilitate a better understanding of industry practices.

- Enhanced Information Resources: Efforts should be made to provide interns with comprehensive information resources and guidance materials to support their learning and execution of tasks. Access to relevant literature, training materials, and mentorship programs would facilitate better preparedness and performance.
- Addressing Gender Biases: Organizations should promote a culture of inclusivity and equality, ensuring equal opportunities for all interns regardless of gender. Measures such as diversity training and awareness programs can help address gender biases and promote a more inclusive work environment.
- Improved Transportation Facilities: Enhancements in transportation facilities or provisions for transportation allowances would alleviate the challenges associated with commuting to the internship site, ensuring punctuality and productivity.

By implementing these recommendations, organizations can optimize the Industrial Training experience, providing interns with a conducive environment for learning, growth, and professional development.

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