INTERNSHIP REPORT

Bachelor of Technology
in
Mechanical Engineering
by

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2 Introduction

As a second-year undergraduate student pursuing Mechanical Engineering at Pandit Deendayal Energy University (PDEU), I undertook a self-initiated internship at **Larsen & Toubro – Precision Engineering & Systems IC (PES IC)**, located in Hazira, Gujarat. Motivated by a strong personal interest in core engineering disciplines—particularly in mechanical design, simulation, and manufacturing—I pursued this internship with the goal of gaining first-hand industrial exposure at one of India's most advanced engineering facilities.

This internship was not part of the mandatory academic curriculum, but rather a proactive step to bridge the gap between classroom learning and the practical demands of the engineering industry. I was particularly drawn to L&T PES IC due to its involvement in high-precision projects across defense, aerospace, and strategic sectors, where quality, reliability, and innovation are paramount. These factors made it an ideal environment for developing a deep understanding of industrial engineering processes and for cultivating real-world problem-solving skills.

I was assigned to the **Production Engineering Department**, which plays a critical role in the conceptualization, design, and development of **Fixtures** and **Special Purpose Machines (SPMs)**. These tools form the backbone of precision manufacturing systems, supporting essential operations such as welding, assembly, inspection, and testing. My responsibilities included engaging with CAD modeling, conducting Finite Element Analysis (FEA), and applying Design for Manufacturability (DFM) principles in actual industrial scenarios.

Through this immersive experience, I aimed to develop not just technical proficiency in tools like Siemens NX and Solid Edge, but also a broader appreciation for how mechanical systems are developed, validated, and optimized within a professional engineering workflow. Working under experienced mentors on challenging real-time problems, I was able to align my academic foundation with real-world application, laying the groundwork for my future endeavors in the fields of mechanical and aerospace engineering.

3 About the Organization

Larsen & Toubro (L&T) is one of India's most respected engineering, procurement, and construction conglomerates, with a global presence and diverse business verticals. My internship was hosted at the **Precision Engineering & Systems IC (PES IC)**, Hazira campus, which plays a strategic role in delivering high-precision engineering solutions, particularly in defense and aerospace sectors.

L&T has been active in the **Defence and Strategic sector since the mid-1980s**, well before private participation was formally allowed. Through close collaboration with the **Defence Research & Development Organization (DRDO)** and **Naval Indigenization programs**, L&T has developed a robust capability in the **design-to-delivery** spectrum of defense equipment and systems.

Today, **L&T Defence** offers indigenous solutions across Naval (submarines, warships), Land Platforms (armoured systems, howitzers), Weapon Systems, Engineering Systems, Missile & Space Launch Vehicle Subsystems, Sensors, Radar Systems, and Avionics. These capabilities are supported by in-house **R&D and Design & Engineering Centres**, enabling full-cycle innovation and development.

A significant highlight of the Hazira campus is the newly established **Armoured Systems Complex (ASC)**. Spread over **50 acres**, it is a world-class facility dedicated to the manufacture, integration, and testing of advanced military armoured platforms such as:

- Self-propelled howitzers
- Air defense systems
- Infantry combat vehicles
- Future-ready combat vehicles and battle tanks

This state-of-the-art facility includes:

- **520-meter-long workshops** with 30 m and 50 m bays
- **Advanced robotic welding systems**
- **CNC machining and system integration** areas
- **Digital monitoring systems** for project management
- **Integrated store and inventory control systems**
- **Full-fledged SP mobility test track** to simulate and test operational performance under real conditions

L&T maintains strict quality standards across all operations. The **Quality Management System (QMS)** at L&T Defence complies with **AS9100 Rev D** and **ISO 9001:2015**, which are international benchmarks for Aviation, Space, and Defence organizations. These standards, developed by the **International Aerospace Quality Group (IAQG)**, ensure continual improvement in product performance and process excellence.

The exposure to such a cutting-edge ecosystem during my internship allowed me to experience how engineering principles, manufacturing practices, and quality control come together in one of India's most strategic industrial settings.

4 Internship Objectives

The internship was strategically undertaken to gain a multi-dimensional understanding of how theoretical engineering knowledge translates into industrial practice. It was designed to enhance **technical depth**, provide **practical insight**, and instill **professional discipline**, essential for any aspiring engineer. The objectives of the internship can be broadly categorized into three focus areas:

4.1 Technical Exposure

4.1.1 Understanding the Industrial Workflow

One of the primary goals was to understand how engineering problems are addressed in an industrial setting. I observed the full design and development cycle—beginning with the identification of manufacturing requirements, progressing through concept ideation, detailed CAD modeling, and simulation-based validation using FEA, and culminating in the implementation of tooling solutions on the shop floor. This provided a holistic view of how design decisions are made in real-time under manufacturing and operational constraints.

4.1.2 Proficiency in CAD Tools

A critical technical objective was to gain fluency in industry-grade software tools. I worked extensively with **Solid Edge** to model mechanical components, subassemblies, and complete fixture systems. Furthermore, I used **Siemens NX** not only for 3D modeling but also for running Finite Element Analysis (FEA) simulations, which allowed me to analyze structural strength and deformation patterns under realistic loading conditions.

4.1.3 Fundamentals of Finite Element Analysis (FEA)

Prior to this internship, FEA was a theoretical concept for me. During my time at L&T, I learned to conduct FEA simulations independently, covering the following aspects:

- Defining material properties and **assigning appropriate boundary conditions**
- Using **split surfaces** to apply accurate and localized load applications
- Performing **mesh generation** and refinement to balance accuracy and computational efficiency
- **Interpreting von Mises stress**, deformation, and displacement results to make informed design decisions
- Troubleshooting common issues such as **meshing failures due to mirrored or complex geometry**

4.1.4 Fixture and SPM Design Principles

Through active observation and hands-on modeling, I gained insight into the foundational principles of fixture and special purpose machine (SPM) design:

- **Clamping and Locating**: Ensuring positional accuracy and repeatability of workpieces
- **Load Path Stability**: Designing load-bearing structures to safely transfer forces without failure
- **Ergonomics**: Taking into account ease of use and operator safety
- **Modularity**: Designing with interchangeable and reusable components to reduce time and cost

4.2 Application & Observation

4.2.1 Shop Floor Integration and Real-World Application

I spent time observing the implementation of designs on the shop floor, where I witnessed the practical challenges that arise when converting digital designs into physical systems. These included:

- **Tolerance stacking** in assemblies leading to misalignments
- **Material variability** affecting weld strength and part fit
- **Operator-dependent variables** such as handling practices and layout adjustments

These observations helped me appreciate the importance of designing not just for function, but also for variability and real-world imperfection.

4.2.2 Design for Manufacturability (DFM)

I gained firsthand experience in tailoring designs to ensure they are easy to fabricate, assemble, and maintain. Key DFM considerations included:

- Ensuring **weld accessibility** and visibility for manual or automated welding operations
- Providing **tool clearance** for machining and fastening
- Using **standard components** wherever possible to minimize costs
- Carefully selecting **surface finishes and tolerances** to meet both functional and fabrication criteria

These insights helped me evaluate my designs through a practical lens, ensuring manufacturability without compromising performance.

4.3 Professional Development

4.3.1 Communication and Technical Documentation

To operate effectively in a collaborative industrial environment, I maintained structured daily logs, developed **part lists and bill of materials (BOMs)**, and created detailed 2D engineering drawings. These included:

- **Geometric Dimensioning & Tolerancing (GD&T)**
- **Weld symbols** and machining notes
- **Material specifications** and surface finish annotations

This documentation ensured clear communication between design, procurement, and fabrication teams.

4.3.2 Understanding Workplace Culture and Team Dynamics

I participated in team discussions and design reviews, learning how engineering decisions are validated by multiple stakeholders such as project leads, procurement managers, and manufacturing supervisors. This taught me the importance of:

- Documenting every iteration and design change
- Justifying choices with data and simulations
- Collaborating respectfully and professionally across departments

4.3.3 Personal Discipline and Soft Skill Development

The internship helped me build a strong professional foundation through daily discipline. I developed key soft skills such as:

- **Punctuality and time management** to meet project timelines
- **Attention to detail** in design and analysis work
- **Active listening and respectful communication** with mentors and colleagues
- A continuous **improvement mindset**, adapting based on feedback and evolving project needs

5 Project Work

During the internship at L&T PES IC, Hazira, I was entrusted with two major projects that were both technically challenging and professionally enriching. These projects were aligned with the core responsibilities of the **Production Engineering Department**, which primarily focuses on the design and development of **Fixtures** and **Special Purpose Machines (SPMs)** for precision manufacturing. Both assignments involved exposure to CAD modeling, FEA simulations, design iterations, and manufacturability assessments.
Note: Due to the confidentiality of defense and strategic-sector projects handled by L&T, specific numerical data, geometries, and CAD outputs have been intentionally excluded.

5.1 Project 1: Finite Element Analysis of a Section Lifting Fixture (~450 Metric Tons)

5.1.1 Objective:

To perform structural analysis on a heavy-duty lifting fixture intended to handle a load of approximately **450 metric tons**, ensuring its mechanical safety, integrity, and functional performance under extreme operational conditions.

5.1.2 Problem Statement:

The initial model of the lifting fixture was a full assembly consisting of multiple parts, constraints, and joints. Simulating such a complex model using FEA was impractical due to:

- The **difficulty in defining contact relations** and constraints across parts
- **Computational inefficiency** due to the size and complexity of the model
- Frequent **meshing failures**, particularly with patterned and mirrored geometry

5.1.3 My Role & Key Contributions:

- **Model Simplification**:
  - Created a **single-part equivalent model** of the fixture that preserved structural behavior while eliminating unnecessary complexity.
  - Paid close attention to maintaining **geometry integrity**, especially around lifting arms, pin connections, and load-bearing sections.
- **Meshing Challenges & Solutions**:
  - Initially used **mirror and pattern features** during part modeling to maintain design symmetry.
  - Encountered **meshing errors** in Siemens NX due to hidden geometric irregularities and mirrored topology.
  - Resolved this by **remodeling the part from scratch**, carefully avoiding mirrored bodies and ensuring geometry cleanliness.
- **FEA Execution in Siemens NX**:
  - Assigned appropriate **material properties** based on design inputs (e.g., high-strength structural steel).

    - Defined **fixed constraints** and applied loads using **split surfaces** to simulate lifting conditions accurately.
    - Refined the mesh to balance **computational efficiency** with **simulation accuracy**.
    - Analyzed **stress distributions**, **deformation zones**, and **safety factors** using von Mises criteria.

5.1.4 Learning Outcomes:

- Understood the **importance of clean geometry** and modeling best practices for simulation success.
- Gained proficiency in using **Siemens NX FEA** environment for high-load structural simulations.
- Learned how to interpret results for engineering decisions—such as areas of stress concentration and potential structural failure points.

5.2 Project 2: Design of a Horizontal Deck Lifting Fixture (~24 Metric Tons)

5.2.1 Objective:

To conceptualize, design, and validate a fixture capable of lifting a **24 metric ton deck assembly** in a **horizontal orientation**, facilitating precise welding inside a **cylindrical shell** as part of a larger integration process.

5.2.2 Design Requirements:

- The deck was **divided into four parts** (each ~6 tons).
- The fixture had to:
    - **Lift the deck from one end** (cantilevered setup)
    - Maintain **horizontal stability**
    - Be **compact** enough to fit into the shell's dimensions
    - Ensure **ease of handling and safety** during the welding operation

5.2.3 My Role & Key Contributions:

- **Conceptualization & Ideation**:
    - Initiated the design with rough sketches, followed by 3D modeling in Solid Edge.
    - Studied previous fixture designs used in similar applications to understand common constraints and performance needs.
- **Structural Strategy & Load Balancing**:
    - Designed a **cantilevered fixture** supported by an **integrated counterweight system**.
    - Evaluated multiple configurations to achieve minimal deflection while maintaining compactness.
    - Ensured appropriate **support points and lifting eyes** were positioned to distribute load evenly and reduce moment arms.
- **Simulation & Design Iteration**:
    - Ran multiple **FEA iterations** in Siemens NX to validate the fixture under expected load and orientation.

- Adjusted **cross-sections**, **support arms** based on stress patterns and deformation readings.
- Achieved an optimal design with a **safety factor greater than 1.5**, under operational loading conditions.

- **DFM Considerations**:
  - Paid close attention to weld accessibility, part modularity, and alignment tolerances.
  - Discussed manufacturability with department engineers and accounted for shop-floor feedback.

5.2.4 Learning Outcomes:

- Gained a complete understanding of **end-to-end fixture design**, from ideation to simulation validation.
- Strengthened my approach to **problem-solving**, adapting designs iteratively based on FEA feedback.
- Learned the critical importance of **balancing theoretical feasibility with manufacturing practicality**.

5.2.5 Summary of Project Impact:

Project	Description	Key Tools Used	Major Skills Gained
Section Lifting Fixture	FEA of simplified model for 450 MT load	Siemens NX, Solid Edge	Clean modeling, boundary conditions, load application
Deck Lifting Fixture	Full design and FEA of 24 MT deck lifting fixture	Siemens NX, Solid Edge	Design ideation, load balancing, simulation iteration, DFM

6 Key Learnings

The internship at L&T PES IC was a transformative experience that allowed me to grow in both technical capability and professional maturity. It provided a rich blend of theoretical application, software proficiency, and exposure to the practicalities of engineering in a high-stakes industrial environment. Below are the key learnings from this experience:

6.1 Comprehensive Understanding of Industrial Design Workflow

Through direct engagement with real engineering tasks, I acquired a deep understanding of how a project evolves through various stages:

- **Requirement gathering**: Understanding the use case, load demands, and spatial constraints
- **Concept development**: Translating verbal briefs or sketches into actionable ideas
- **CAD modeling**: Creating parametric models that are editable, accurate, and clean
- **Simulation validation**: Using tools like FEA to check design feasibility
- **Deployment on the shop floor**: Observing real-life implementation and feedback cycles

I realized that industrial design is not a linear process—it is iterative, collaborative, and constrained by multiple practical factors like cost, time, and manufacturability.

6.2 Proficiency in CAD and Simulation Tools

The internship allowed me to develop proficiency in two key software platforms:

- **Solid Edge** for 3D part and assembly modeling
- **Siemens NX** for Finite Element Analysis (FEA)

I learned best practices in:

- Sketching and parametric modeling
- Assembly design and part relations
- Applying loads, boundary conditions, and constraints in simulation
- Mesh generation and interpretation of simulation results
- Reading von Mises stress plots and deformation contours to make engineering decisions

This hands-on exposure built my confidence in using software not just as a design platform but as an engineering analysis tool.

6.3 Bridging Theory with Practice

Textbook topics like:

- Beam theory
- Load paths and shear force
- Stress-strain relationships
- Weld strength
- Factor of safety

…were no longer abstract. They became tangible and directly applicable in my daily tasks. I saw how real components behave under simulated loads, how joint types impact load distribution, and how simplifying assumptions in academics are adjusted for real-world constraints.

6.4 Design for Manufacturability (DFM) Awareness

Before this internship, I considered design success purely from a functional point of view. However, I learned that **a good design is one that can actually be built**.
DFM considerations became an essential filter through which I refined my concepts:

- Ensuring accessibility for welding, fastening, or assembly tools
- Considering standard part sizes to reduce cost
- Avoiding overly complex geometry that is difficult to fabricate or machine
- Designing for modularity and ease of transport

This mindset made me appreciate the trade-offs engineers must constantly make between ideal design and feasible manufacturing.

6.5 Drafting and Documentation Standards

I gained substantial experience in preparing **production-ready engineering drawings**, which included:

- Proper dimensioning practices
- Use of **GD&T** (Geometric Dimensioning & Tolerancing)
- Inclusion of **surface finish requirements**, **weld symbols**, and **material notes**
- Structured **Bill of Materials (BOMs)**

Such documentation is crucial for cross-functional clarity between design, fabrication, quality, and procurement teams.

6.6 Simulation Strategy and Troubleshooting

FEA isn't just about running a simulation—it's about knowing how to set it up, interpret it, and trust its results. I learned:

- Why mirrored or complex geometries cause **meshing errors**
- The difference between **ideal constraints** and **realistic boundary conditions**
- How to **refine meshes** for accurate results without increasing computation time unnecessarily
- The value of **split surfaces** for precise load application

By debugging issues step-by-step, I developed a logical approach to simulation problem-solving.

6.7 Innovation and Forward Thinking

During internal discussions, I was encouraged to think beyond assigned tasks and suggest ideas that could improve departmental workflows. Two such suggestions included:

- **Additive Manufacturing** for faster prototyping of small fixtures
- **AI-driven shop floor safety monitoring**, using sensors and alerts to reduce human error in high-risk operations

These ideas were well-received and taught me that innovation is not just welcomed in industry—it is essential.

6.8 Development of Professional Discipline

The structured nature of the internship helped instill essential workplace habits such as:

- Maintaining **daily logs** of tasks and progress
- Participating in **team stand-up meetings** and updates
- Respecting **deadlines and documentation protocols**
- Practicing **clarity in communication**, both verbal and written
- Learning from feedback and iterating designs accordingly

These soft skills are as important as technical abilities in building a successful engineering career.

7 Challenges Faced

No meaningful learning experience is complete without challenges. The obstacles I encountered during this internship taught me valuable lessons in resilience, adaptability, and resourcefulness.

7.1 Transitioning to Industrial-Grade Software

As a student accustomed to academic software, transitioning to tools like **Solid Edge** and **Siemens NX** was initially overwhelming. These platforms have extensive feature sets and demand precision in modeling, constraints, and assemblies. It took time and effort to:

- Understand software-specific workflows
- Avoid modeling shortcuts that caused downstream issues
- Align my designs with department standards and templates

However, this challenge ultimately accelerated my growth as a CAD designer.

7.2 Learning FEA from Scratch

Before the internship, I had no hands-on experience with **Finite Element Analysis (FEA)**. Concepts like meshing, stress plots, and boundary conditions were theoretical. During the internship:

- I had to quickly grasp the **physics behind simulations**
- Understand how incorrect load placement or constraints could yield misleading results
- Troubleshoot and refine simulation setups through trial and error

Despite the steep learning curve, FEA soon became one of the most rewarding aspects of my internship.

7.3 Meshing Failures Due to Modeling Errors

A particularly tough challenge came when my first fixture model failed to mesh. The issue was traced to the use of **mirrored geometry**, which created discontinuities that the solver could not process.
Resolution:

- Rebuilt the entire part from scratch using clean geometry
- Avoided mirror and pattern features that introduce hidden surface inconsistencies
- Validated each element of the model before simulation

This experience taught me the importance of geometry quality in simulation accuracy.

7.4 Limited Access Due to Project Confidentiality

Because L&T operates in **defense and strategic sectors**, many of the designs and specifications are confidential. This meant:

- I could not access full project data or participate in certain high-level discussions
- Final project documentation and design files were internally restricted

While limiting in some ways, this reinforced the importance of **data security**, **professional discretion**, and **ethical conduct**—critical in sensitive industrial domains.

7.5 Bridging the Academic–Industry Gap

One of the biggest realizations was how different industrial problems are from textbook problems:

- Tolerances are never perfect
- Materials behave differently in real environments
- Human error must be accounted for in design
- Real projects are full of **unpredictable constraints**—from space limitations to vendor delays

Learning to design within these limitations, while still meeting safety and performance goals, was one of the most eye-opening parts of the internship.

8 Reflections and Recommendations

8.1 Reflections

Reflecting on my two-month internship at **L&T Precision Engineering & Systems IC (PES IC), Hazira**, I can confidently say that the experience exceeded my expectations in terms of learning, growth, and exposure. As a second-year student, getting hands-on involvement in the design and validation of mechanical systems that contribute directly to national defense and aerospace applications was both humbling and inspiring.

One of the most valuable aspects of the internship was the **opportunity to work on real industrial problems**. Unlike textbook exercises with fixed variables and ideal conditions, the tasks assigned to me required adapting to uncertainties—be it fluctuating load assumptions, geometric constraints, or shop-floor limitations. This taught me that real-world engineering is not just about solving problems but about solving the **right** problems within constraints of time, cost, manufacturability, and safety.

The **mentorship I received** played a vital role in shaping my approach. My seniors and mentors were generous with their knowledge, taking time to explain not just "how" things are done but also "why" they are done that way. Whether it was discussing fixture loading paths, interpreting stress patterns in FEA, or ensuring that a design is manufacturing-friendly, these interactions helped me internalize engineering decision-making.

I also realized the **value of interdisciplinary thinking**. Successful execution of a project involved inputs from design engineers, simulation analysts, procurement officers, and shop-floor technicians. Watching how different departments align toward a common goal gave me a broader understanding of how large-scale engineering systems operate. It helped me appreciate the **importance of documentation, version control, effective communication**, and cross-functional coordination.

Moreover, my exposure to simulation, modeling, drafting standards, and the entire lifecycle of fixture development gave me a strong foundation in **mechanical design thinking**. It reinforced my desire to pursue further opportunities in the fields of **aerospace, defense systems, and mechanical R&D**.

This internship did more than improve my technical skills—it also built my confidence, honed my discipline, and gave me a clearer vision of what kind of engineer I want to become.

8.2 Recommendations

Based on my experience, I would like to share a few suggestions for students, faculty, and industry mentors that can help enhance the value of similar internship programs:

8.2.1 For Students:

- **Start early**: Don't wait until your final year to seek industrial exposure. Early internships offer a competitive edge and shape your learning path.
- **Master CAD and Simulation basics** before joining an internship to spend more time applying knowledge rather than learning software from scratch.
- **Be proactive**: Ask questions, take notes, seek feedback, and volunteer for additional tasks. Your learning is limited only by your curiosity.

8.2.2 For Faculty & Universities:

- Encourage students to take up **non-credit internships** during semester breaks or summer holidays.
- Integrate tools like **Solid Edge, Siemens NX, and FEA** software into the academic curriculum to reduce the industry-academia gap.
- Facilitate **collaborations with companies** like L&T that can offer project-based internships for early-year students.

8.2.3 For Industry Mentors:

- Continue fostering a culture of mentorship, where interns are given not just tasks but also context and reasoning behind engineering decisions.
- Encourage interns to **document their work and learning**—it helps them reflect and contributes to knowledge continuity for future batches.

This internship has deeply impacted my personal and professional trajectory. It has made me more focused, more skillful, and more aware of the real-world expectations from a mechanical engineer. I now look forward to building upon this experience through academic projects, advanced design work, and eventually contributing to India’s aerospace and defense sectors.

9 Acknowledgements

I would like to express my heartfelt gratitude to all those who supported, guided, and inspired me throughout my internship at **L&T – Precision Engineering & Systems IC, Hazira**. This experience has been deeply enriching and would not have been possible without the contributions of several individuals and institutions.

First and foremost, I extend my sincere thanks to **Dr. Vishvesh Badheka**, Faculty Mentor at **Pandit Deendayal Energy University (PDEU)**, for his encouragement and consistent academic guidance. His mentorship played a pivotal role in helping me secure this opportunity and maximize its learning potential.

I am especially grateful to my mentors at L&T PES IC — **Mr. Jay M. Patel** and **Mr. Rushi Vyas** — for their unwavering support, technical insights, and hands-on guidance. Their patience, expertise, and willingness to share knowledge created a nurturing learning environment where I felt both challenged and supported.

I would also like to acknowledge the entire team of the **Production Engineering Department** for welcoming me into their workflow, involving me in meaningful projects, and offering valuable feedback at every step. The collaborative spirit and professionalism I witnessed here have left a lasting impression on me.

Lastly, I am thankful to my peers, family, and friends who encouraged me to pursue this internship and stood by me throughout the journey.

This internship has significantly contributed to my growth as a mechanical engineering student, and I am confident that the skills and experiences gained here will serve as a strong foundation for my future academic and professional endeavors.