

A Study of Quality Control and Manufacturing Processes in the Automobile Component Industry

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ABSTRACT— Quality control and precision manufacturing form the backbone of the modern automobile component industry. This research paper explores the fundamental quality control practices, precision machining operations, and inspection techniques implemented during industrial training at Sai Tech Enterprises, Ahilyanagar. The study focuses on the operational workflow of Computer Numerical Control (CNC) machining, drilling, and tapping processes used in producing high-precision automotive components. Key methodologies including Statistical Process Control (SPC), First Article Inspection (FAI), and In-Process Gauge Inspections are analyzed. The paper highlights defect prevention strategies, common machining tolerances, and continuous quality improvement frameworks essential for minimizing rejections and meeting stringent automotive standards (ISO 9001/IATF 16949). The practical exposure gained provides critical insights into aligning academic mechanical engineering concepts with real-world industrial shop-floor manufacturing.

Keywords: *Quality Control, Automobile Components, Manufacturing Processes, CNC Machining, Dimensional Inspection, Defect Prevention, Industrial Training.*

1. INTRODUCTION

The automotive manufacturing sector demands rigorous quality assurances, ultra-tight dimensional tolerances, and high repeatability. Automobile components such as engine blocks, gear blanks, shafts, and brake assemblies undergo intensive mechanical processing where even minor dimensional deviations can lead to assembly failures or mechanical breakdowns. Quality Control (QC) is not merely a final inspection phase but a continuous, systemic approach integrated throughout the entire manufacturing lifecycle.

During the industrial training program at Sai Tech Enterprises, Ahilyanagar, practical exposure was gained in precision component fabrication, CNC operations, drilling, tapping, and quality inspection workflows. This study documents the empirical findings, methodologies, and quality control systems observed and executed on the shop floor.

2. MANUFACTURING PROCESSES AT SAI TECH ENTERPRISES

The production workflow for precision automotive components involves primary material preparation followed by accurate secondary machining operations. The primary operations executed include:

2.1 Computer Numerical Control (CNC) Machining

CNC turning and vertical machining centers (VMC) are utilized for high-precision shape generation. Pre-programmed G-codes and M-codes control tool paths, feed rates, and spindle speeds, ensuring sub-micron accuracy across large batch sizes.

2.2 Drilling & Tapping Operations

Precision drilling is performed to create accurate mounting holes, followed by internal threading via tapping processes. High-speed steel (HSS) and carbide taps are employed along with suitable cutting fluids to prevent thread stripping and thermal distortion.

3. QUALITY CONTROL METHODOLOGIES

To uphold automotive standards, a multi-stage inspection mechanism is enforced on the shop floor:

1. Incoming Material Inspection: Verifying raw material hardness, surface integrity, and chemical composition certifications prior to loading.

2. First Article Inspection (FAI): The first component produced after every machine setup is comprehensively measured against engineering drawings before bulk manufacturing commences.
3. In-Process Quality Inspection: Machine operators use calibrated instruments (Vernier Callipers, Micrometers, Plug Gauges, Thread Gauges) at specified intervals (e.g., every 5th or 10th component).
4. Final Pre-Dispatch Quality Audit: Sampling inspection ensuring zero burrs, correct surface finish (Ra values), and perfect thread compliance.

Table 1: Key Quality Control Instruments and Applications

Inspection Instrument	Measurement Parameter	Tolerance Range / Accuracy
Digital Vernier Calliper	Outer/Inner Diameter, Depth, Length	± 0.02 mm
Outside Micrometer	Critical Shaft Diameters & Thickness	± 0.001 mm
Go / No-Go Plug Gauges	Bore Diameter Verification	Goes through / Stops
Thread Pitch Gauges	Internal & External Thread Pitch	Standard ISO Metric

4. DEFECT ANALYSIS AND REDUCTION STRATEGIES

In industrial manufacturing, minimizing rejections directly impacts profitability. Common defects encountered during CNC turning and tapping include dimensional tolerance slip, tool chatter marks, burr formation, and thread damage. Root cause analysis led to the following corrective actions:

- Tool Wear Management: Scheduled indexable insert replacements based on cycle count rather than visual wear.
- Coolant Optimization: Maintaining recommended coolant concentration (6-8%) and flow pressure to minimize thermal expansion.
- Fixture Rigidity: Ensuring robust pneumatic/hydraulic clamping to eliminate vibration during high-speed cutting.

5. CONCLUSION

The practical industrial training at Sai Tech Enterprises provided invaluable real-world engineering exposure. Implementing systematic Quality Control frameworks—from incoming raw material validation to in-process gauge checks—ensures consistent production of defect-free automotive components. A thorough understanding of machining parameters, quality inspection protocols, and defect root-cause analysis is indispensable for modern mechanical engineers aiming to drive manufacturing excellence.

6. ACKNOWLEDGEMENT

The author expresses sincere gratitude to the management and technical staff of Sai Tech Enterprises, Ahilyanagar, for providing guidance and practical training opportunities. Special thanks to the faculty and Head of the Department (HOD), Department of Mechanical Engineering, Sau. Sundarabai Manik Adsul Polytechnic, Ahilyanagar, for their constant encouragement and academic support.

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AUTHOR DECLARATION

I hereby declare that the research paper titled 'A STUDY OF QUALITY CONTROL AND MANUFACTURING PROCESSES IN THE AUTOMOBILE COMPONENT INDUSTRY' is an authentic record of work carried out by me during my industrial training under the guidance of Mechanical Engineering Department, Sau. Sundarabai Manik Adsul Polytechnic, Ahilyanagar.

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