

“A Case Study on Quality Inspection and Quality Control Practices at Kinetic Engineering Limited, Ahilyanagar.”

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Abstract

Quality inspection is a critical function in automotive component manufacturing because dimensional accuracy, material properties, assembly precision, and functional performance directly influence vehicle safety, reliability, and customer satisfaction. This research paper presents a case study of quality inspection and quality-control practices at **Kinetic Engineering Limited (KEL), Ahilyanagar**, with particular emphasis on machining components, transmission and driveline parts, chassis components, body panels, and electric-vehicle-related components.

Kinetic Engineering operates a vertically integrated manufacturing facility at Ahilyanagar with more than 32 production sheds and over 460 machines. The facility includes processes such as forging, gear cutting, heat treatment, precision machining, painting, plating and electric drivetrain assembly and is IATF 16949 certified.

The study examines incoming inspection, in-process inspection, final inspection, dimensional measurement, surface inspection, automated gauging, welding inspection, paint-quality inspection, and documentation. Recent developments at the Ahilyanagar facility include automated inspection systems, individual gauges for components, robotic welding and upgraded production systems for electric scooters.

Keywords: Quality Inspection, Quality Control, Kinetic Engineering, Ahilyanagar, Automotive Components, Dimensional Inspection, Gauging, Machining, EV Components, IATF 16949.

1. Introduction

The automotive industry requires a high level of manufacturing accuracy because even a small dimensional or functional error in a component can affect the performance and safety of the

complete vehicle.

Quality inspection is therefore integrated throughout the manufacturing process rather than being limited to final inspection. Important inspection activities include:

- Raw-material inspection
- Dimensional inspection
- In-process inspection
- Surface-finish inspection
- Gear inspection
- Heat-treatment verification
- Welding inspection
- Assembly inspection
- Functional testing
- Final inspection

Kinetic Engineering Limited has more than five decades of automotive manufacturing experience. Its Ahilyanagar facility has extensive in-house manufacturing capabilities covering forging, gear cutting, heat treatment, precision machining, painting, plating and electric drivetrain assembly.

The company has also introduced automated inspection and gauging systems to reduce dependence on manual inspection and improve consistency.

2. Objectives of the Study

The main objectives of this research are:

1. To study the quality inspection system followed in automotive component manufacturing.
2. To understand incoming, in-process and final inspection.
3. To study dimensional inspection of machined components.
4. To study the use of gauges and measuring instruments.
5. To understand automated inspection systems.
6. To study inspection of chassis and welded components.
7. To study quality inspection of electric-vehicle components.
8. To identify common manufacturing defects.

9. To study quality-control documentation and traceability.
10. To suggest improvements in quality inspection practices.

3. Organization Profile

Kinetic Engineering Limited (KEL) is an automotive manufacturing company and part of the Kinetic Group.

Its Ahilyanagar manufacturing facility is a major integrated manufacturing location. Public company information describes the facility as being spread over more than 50 acres, with more than 32 production sheds and more than 460 machines. The facility has more than 1,000 employees and supports multiple manufacturing processes.

The manufacturing ecosystem includes:

- Forging
- Gear manufacturing
- Heat treatment
- Precision machining
- Transmission components
- Driveline components
- Chassis manufacturing
- Painting
- Plating
- Electric drivetrain assembly
- Electric two-wheeler components

The facility is **IATF 16949 certified**, reflecting its automotive quality-management focus.

4. Research Methodology

The study can be carried out using the following methodology:

Industrial Study



Study of Manufacturing Process



Identification of Quality Characteristics



Incoming Inspection



In-Process Inspection



Dimensional Inspection



Functional Inspection



Final Inspection



Defect Analysis



Corrective and Preventive Action

The research methodology consists of:

- Industrial observation
- Study of manufacturing processes
- Study of inspection instruments

- Discussion with production and quality personnel
- Study of inspection records where authorized
- Analysis of common defects
- Study of quality-improvement techniques

5. Quality Inspection System

Quality inspection at an automotive manufacturing facility can broadly be divided into three stages.

5.1 Incoming Inspection

Raw materials and purchased components are inspected before entering production.

Typical checks include:

- Material identification
- Material certificates
- Dimensional verification
- Surface condition
- Visual inspection
- Quantity verification
- Supplier quality documentation

The objective is to prevent defective material from entering the manufacturing process.

5.2 In-Process Inspection

In-process inspection is performed during manufacturing.

Typical parameters include:

- Diameter
- Length
- Thickness
- Bore diameter
- Hole position
- Flatness
- Parallelism
- Perpendicularity
- Surface finish
- Thread dimensions
- Gear dimensions
- Heat-treatment parameters
- Weld quality

In-process inspection helps identify defects at an early stage and reduces rejection and rework.

5.3 Final Inspection

Final inspection is performed before components are transferred to the next process or dispatched to the customer.

Typical checks include:

- Dimensional accuracy
- Visual appearance
- Surface finish
- Functional requirements
- Assembly compatibility
- Identification marking
- Documentation
- Packaging condition

6. Inspection of Machined Components

Machining is one of the important manufacturing activities in automotive component production.

Typical machining operations include:

- Turning
- Facing
- Drilling
- Boring
- Milling
- Grinding
- Gear cutting
- Threading

Quality inspection is required after critical machining operations.

Important parameters

Parameter	Inspection method
Outside diameter	Micrometer
Inside diameter	Bore gauge
Length	Vernier caliper
Hole diameter	Plug gauge
Thread	Thread gauge
Surface finish	Surface roughness instrument
Flatness	Surface plate/gauge
Runout	Dial indicator
Gear dimensions	Gear inspection equipment

7. Automated Gauging and Inspection

One of the important quality developments reported by Kinetic Engineering is the use of **automated gauging systems**.

The company's FY 2024–25 reporting describes a human-less gauging system for components and automated gauging for selected precision components. The purpose is to reduce manual errors and improve inspection speed and consistency.

The basic concept is:

Component → Automatic Measurement → Comparison with Specification → OK/Not OK Decision → Data Recording

Advantages

- Reduced human error
- Faster inspection
- Consistent measurement
- Improved repeatability
- Reduced inspection time
- Better traceability
- Early detection of defective components

8. Quality Inspection of Chassis

Chassis quality is particularly important because the chassis forms the structural framework of the vehicle.

Kinetic Engineering has introduced a robotic chassis line at its Ahilyanagar facility for the Kinetic DX electric scooter. The system includes robotic welding, automated clamping fixtures and a dedicated scooter framing cell.

Important chassis inspection parameters

1. Overall dimensions
2. Mounting-hole position
3. Weld location
4. Weld consistency
5. Frame alignment
6. Dimensional accuracy
7. Joint integrity
8. Surface condition
9. Deformation
10. Corrosion protection

Robotic welding can provide greater repeatability because welding parameters and movement can be controlled consistently.

9. Welding Quality Inspection

Welding inspection is important for chassis and fabricated components.

Common inspection methods

- Visual inspection
- Weld-bead inspection
- Dimensional inspection
- Joint alignment inspection
- Weld penetration verification where applicable
- Destructive/non-destructive testing as specified by the applicable procedure

Common welding defects

- Porosity
- Undercut
- Lack of fusion
- Cracks
- Excessive weld spatter
- Improper weld size
- Distortion

The introduction of robotic welding at Kinetic's Ahilyanagar facility is intended to improve precision and consistency in chassis manufacturing.

10. Inspection of Body Panels

The manufacturing facility has upgraded systems for metal body-panel production using hydraulic and mechanical presses, spot-welding systems and pneumatic fixtures.

Quality inspection of body panels may include:

- Length
- Width
- Thickness
- Hole position
- Profile
- Bend angle
- Surface defects
- Dent inspection
- Burr inspection

- Dimensional conformity

Common defects

- Dent
- Scratch
- Crack
- Burr
- Wrong hole location
- Excessive deformation
- Incorrect bend
- Surface damage

11. Paint Quality Inspection

Surface finishing is an important quality characteristic in automotive products.

Kinetic's upgraded paint shop includes a seven-tank process incorporating CED coating and metallic finishing. The process is intended to improve corrosion resistance and surface appearance.

Paint inspection parameters

- Surface appearance
- Coating uniformity
- Colour
- Adhesion
- Surface defects
- Corrosion resistance
- Coating thickness, where specified

Common paint defects

- Uneven coating
- Pinholes
- Blistering
- Dust inclusion
- Runs
- Colour variation
- Poor adhesion

12. Quality Inspection of EV Components

With increasing electric-vehicle production, quality inspection also becomes important for:

- Electric drivetrain components
- Motor-related components
- Battery-related components
- Chassis
- Wiring systems
- Connectors
- Mechanical transmission components
- Structural parts

Kinetic Engineering identifies EV as one of its major business verticals, while its Ahilyanagar facility supports electric drivetrain and related manufacturing activities.

For EV-related components, inspection should consider both **mechanical and electrical characteristics**, according to the relevant component specification and approved test procedure.

13. Inspection Instruments

Typical inspection instruments used in automotive manufacturing include:

Sr. No.	Instrument	Application
1	Vernier Caliper	Length/diameter
2	Micrometer	Precision measurement
3	Height Gauge	Height and location
4	Bore Gauge	Internal diameter
5	Plug Gauge	Hole inspection
6	Ring Gauge	External diameter
7	Thread Gauge	Thread inspection
8	Dial Indicator	Runout/alignment
9	Surface Roughness Tester	Surface finish
10	CMM	Complex dimensional inspection
11	Hardness Tester	Material hardness
12	Automated Gauge	Automatic dimensional inspection

Note: The exact instruments, models and specifications used for a particular Kinetic production line should be confirmed from authorized plant records or industrial-visit observations.

14. Quality Control Tools

The following quality tools can be applied to quality inspection:

14.1 Pareto Analysis

Used to identify the major sources of rejection.

Example categories:

- Dimensional error
- Surface defect
- Welding defect
- Material defect
- Assembly error

14.2 Fishbone Diagram

Possible causes can be classified under:

Man – Machine – Method – Material – Measurement – Environment

14.3 5 Why Analysis

Used to determine the root cause of repeated defects.

14.4 Check Sheet

Used for systematic recording of defects.

14.5 Control Chart

Used for monitoring process variation.

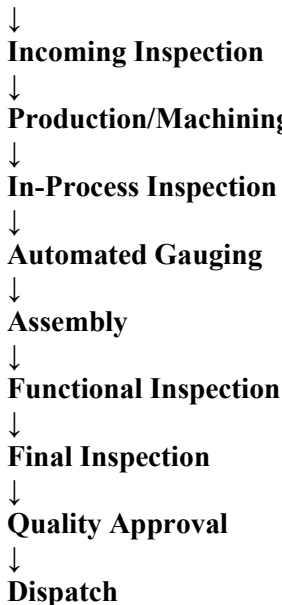
14.6 Poka-Yoke

Error-proofing techniques prevent incorrect operations from proceeding to the next stage.

Kinetic's reported use of automated gauging and "Do Not Run" defect-prevention systems illustrates the application of error prevention within manufacturing processes.

15. Quality Inspection Flow

Proposed Quality Inspection Flow Raw Material



This approach ensures that defects are identified as close as possible to their point of occurrence.

16. Defect Analysis

Common defects that may be studied during an industrial quality investigation include:

Defect	Possible Cause	Corrective Action
Oversize/under size	Tool wear	Tool replacement
Hole error	Improper setting	Machine setting verification
Surface roughness	Tool condition	Tool/process correction
Weld defect	Welding parameter variation	Parameter control
Frame misalignment	Fixture error	Fixture inspection
Burr	Improper cutting condition	Deburring/process correction
Paint defect	Surface preparation	Process control
Assembly error	Wrong component/operation	Poka-Yoke

These should be treated as **study categories**, not as confirmed Kinetic defect statistics unless actual company records are available.

17. Quality Performance Indicators

For an academic study, the following KPIs can be calculated using actual authorized plant data.

Rejection Rate

$$\text{Rejection Rate} = \frac{\text{Rejected Components}}{\text{Total Components Inspected}} \times 100$$

First Pass Yield

$$FPY = \frac{\text{Components Accepted First Time}}{\text{Total Components Produced}} \times 100$$

Defect Rate

$$\text{Defect Rate} = \frac{\text{Number of Defective Components}}{\text{Total Components Inspected}} \times 100$$

Inspection Effectiveness

$$\text{Inspection Effectiveness} = \frac{\text{Defects Detected}}{\text{Total Defects}} \times 100$$

Actual values should be calculated from authorized Kinetic production/quality records rather than estimated figures.

18. Major Quality Improvements Observed/Reported

Kinetic Engineering's recent manufacturing initiatives demonstrate increasing use of automation and digital quality control.

Important developments include:

- Automated gauging
- Human-error prevention systems
- Robotic chassis welding
- Automated clamping fixtures
- Individual gauges for components
- Digitized parts storage
- Kit-based component supply
- Improved body-panel manufacturing
- Upgraded paint processes
- Enhanced inspection/test systems

These developments support greater process consistency, reduced manual errors and improved manufacturing quality.

19. Recommendations

Based on the quality-inspection study, the following practices are recommended:

1. Increase automated inspection for critical dimensions.
2. Maintain calibration records for all measuring instruments.
3. Use SPC for critical machining characteristics.
4. Implement Poka-Yoke at high-risk operations.
5. Strengthen traceability of critical components.
6. Use digital inspection records wherever practical.

7. Conduct regular gauge capability studies.
8. Monitor tool wear and its relationship with dimensional variation.
9. Use Pareto analysis for repeated rejection.
10. Conduct regular operator quality-awareness training.
11. Integrate inspection data with production data.
12. Expand vision-based inspection for suitable components.

20. Results and Discussion

The case study indicates that quality inspection in modern automotive manufacturing is moving from conventional end-of-line inspection toward **process-integrated and automated quality assurance**.

The use of automated gauging reduces dependence on manual measurement, while robotic welding provides repeatable manufacturing conditions. Kinetic's reported introduction of automated inspection, robotic chassis welding and individual component gauging demonstrates this transition at its Ahilyanagar manufacturing operations.

An important finding of the study is that **quality should be built into the manufacturing process rather than inspected only after production**. Early detection of dimensional, welding, surface and assembly defects can reduce rework, rejection and customer complaints.

21. Conclusion

This research paper studied the **quality inspection and quality-control practices associated with Kinetic Engineering Limited, Ahilyanagar**.

The study highlights the importance of incoming inspection, in-process inspection, dimensional measurement, automated gauging, welding inspection, paint inspection and final quality verification in automotive manufacturing.

Kinetic Engineering's Ahilyanagar facility has adopted advanced manufacturing and inspection technologies, including automated gauging, robotic chassis welding, automated fixtures and improved component quality checks.

The study concludes that the combination of **IATF 16949-based quality systems, skilled personnel, calibrated measurement systems, automation, Poka-Yoke, data-based inspection and continuous improvement** can contribute significantly to consistent product quality and manufacturing reliability.

22. Future Scope

Future research can focus on:

- Statistical analysis of actual rejection data
- Pareto analysis of machining defects
- CMM-based dimensional analysis
- SPC implementation
- Gauge R&R study
- OEE and quality correlation
- Automated vision inspection
- AI-based defect detection
- Digital traceability
- Quality analysis of EV components
- Comparison of manual and automated inspection

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