1. Reported Issue

- Operator reported poor surface finish on aluminum workpiece.
- Increased vibration and unusual noise from the spindle during operation.
- Cutting tool appeared dull and discolored after inspection.
- Power consumption increased by 15% compared to normal operation.

2. Initial Diagnosis

Observations:

- Surface quality degraded – Workpiece showed excessive burr formation.
- Vibrations detected – Indicated potential tool imbalance or excessive wear.
- Cutting force increased – Load monitoring showed 20% increase in spindle load.
- Coolant flow normal – No blockages detected in coolant nozzles.

Tests Conducted:

- Tool Wear Measurement: Measured tool wear exceeded 0.35mm (recommended limit: 0.3mm).
- Run-out Test: Measured spindle run-out at 0.012mm (within tolerance).
- RPM & Torque Monitoring: Found irregular fluctuations in spindle torque.

3. Corrective Actions Taken

1. **Tool Replacement**
    - Removed worn-out end mill (Carbide, 12mm, 2-flute).
    - Installed new tool (same specifications).
2. **Recalibration**
    - Recalibrated tool offsets using touch probe.
    - Verified spindle alignment with dial indicator.
3. **Test Run & Verification**
    - Performed dry run without material to check for vibrations.
    - Conducted test cut on scrap aluminum to verify surface finish.
    - Measured cutting forces—returned to normal operational range.

Final Outcome:

- Surface quality restored – No more burr formation.
- Vibrations eliminated – Spindle running smoothly.
- Power consumption normalized – Reduced back to standard levels.

- No further anomalies detected after final monitoring check.

4. Root Cause Analysis

Primary Cause:

- Excessive tool wear due to extended usage beyond recommended limits.

Contributing Factors:

- Increased feed rate in previous operations accelerated wear.
- Lack of regular tool inspection – Scheduled checks not followed strictly.

5. Preventive Measures & Recommendations

- Increase frequency of tool inspections
    - Implement automated tool wear monitoring via spindle load tracking.
    - Require manual visual inspections every 50 machining hours.
- Optimize cutting parameters
    - Reduce feed rate by 10% to extend tool life.
    - Use high-speed machining strategies to lower cutting forces.
- Preemptive tool replacement policy
    - Change tool after 200 minutes of cutting time instead of 250.
    - Set automatic wear limit alerts in the CNC control system.
- Operator training enhancement
    - Conduct training on early signs of tool wear detection.
    - Improve documentation of tool usage logs for future reference.

6. Next Scheduled Maintenance Check

- Follow-up inspection scheduled for February 10, 2025.

Supervisor Approval:

- Signed by: Lead Maintenance Engineer, Thomas Richter
- Status: Machine operational and back in service