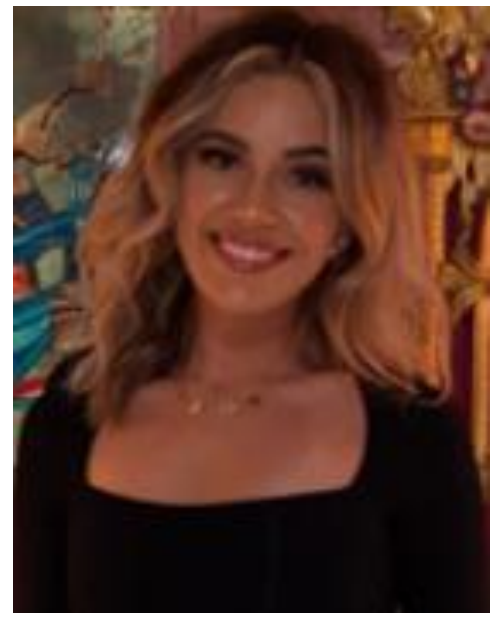




Detachment of the Ball from the Stem on a Micro-Sized Stylus

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1. Conclusion

The investigation identified variation in concentricity exceeding 0.03 mm as the root cause of ball detachment, reducing product reliability. Corrective actions, including fixture replacement, maintenance scheduling, and design improvements, significantly improved process capability and eliminated the defect. The failure rate was reduced to 0%, inspection was removed which met the project aims, following validation, and customer confidence was fully restored.

2. Introduction

A stylus (Figure 1) is the most critical component on a CMM, as this component directly interacts with the workpiece to collect measuring data.

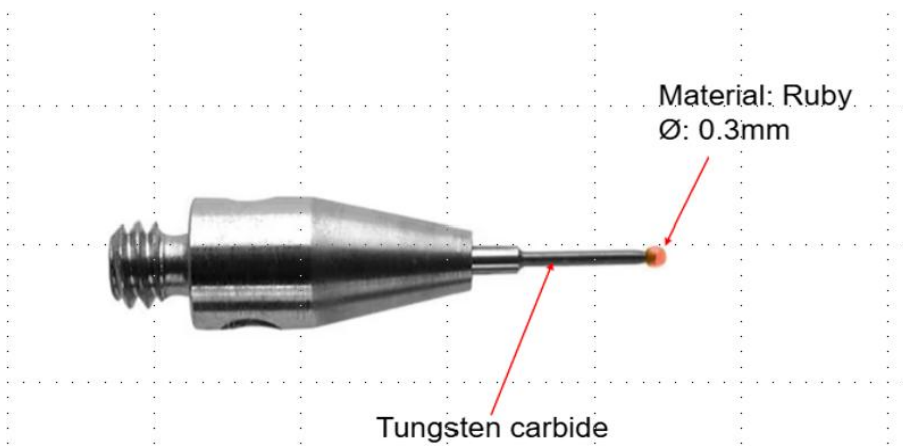


Figure 1: Micro-size (1mm) Stylus product.

3. Project Aims

- Identify root cause
- Target failure rate: 0.4% (Addressing a quality issue that previously incurred £124,120.50 in defect-related costs).
- Target inspection value: 0%

4. Methodology

This projects applies the Six Sigma DMAIC methodology to identify and investigate root cause, improve product Quality.

5. DMAIC:

- **Define:** Customer reported 55 defective units with the ruby ball detaching from the stem.
- **Measure:** Quantifying data using an Opticline Measuring Machine. Initial 30% failure rate was found during Renishaw's stock inspection.
- **Analyse:** Concentricity exceeding 0.03mm tolerance
- **Improvement:** Fixture maintenance schedule was introduced, and the stem design was improved to support better alignment, resulting in improved process capability.
- **Control:** Supplier's maintenance schedules were implemented, and a reaction plan was introduced to prevent recurrence.

6. Results

A cause-and-effect diagram was conducted to highlight potential root causes. All potential root causes was considered, the primary causes selected for further investigation were highlighted in the Cause and Affect diagram.

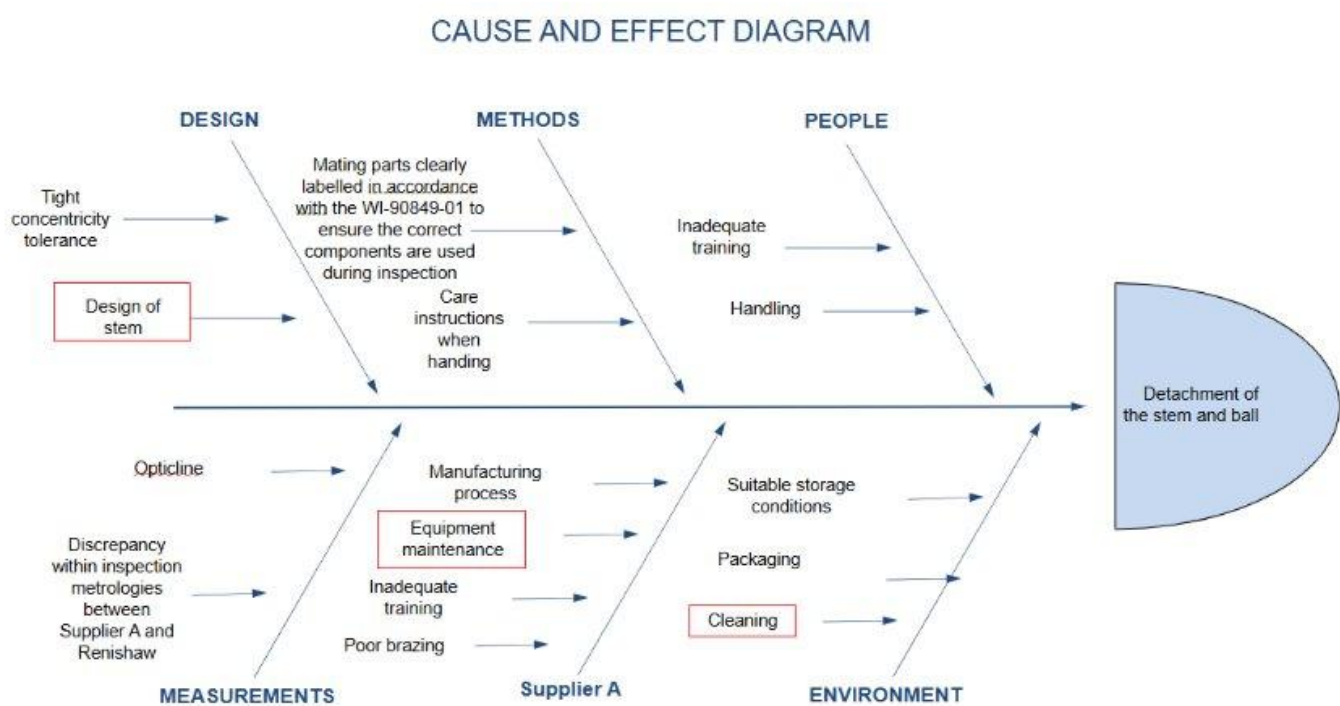


Figure 29: Ishikawa diagram (Ishikawa diagram)

7. Key findings:

Design of stem: Stem was not optimised for Design For Manufacture (DFM) resulting in inconsistent bonding.

Equipment maintenance: lack of maintenance led to poor conditions of fixtures.

Cleaning: was investigated but showed no impact on concentricity

8. Results

A Defective Material Report was created by the Supplier and sent back to Renishaw for review and approval.

Figure 42: Customer Solution Report (CSR)

9. Key findings:

Root cause:

1. Lack of a maintenance schedule causing fixture wear and misalignment.
2. Design of Stem not suitable (highlighted in Figure 29)

Verification: Comparative trials using new and worn fixtures confirmed fixture wear as primary cause. Components made with new fixtures met specification; those from worn fixtures did not.

Corrective actions:

- Introduced a 6-month maintenance schedule to inspect fixtures for wear.
- Remade fixtures which reduced failure rate to 5% from 30%. (Estimat4ed cost reduction of £6,206.03 (95%))
- Re-designed stem by introducing a 'V' shaped seating feature, reducing failure rate from 5% to 0%. (Estimated reduced cost of £6,206.03 to £0)

Standardisation: Corrective actions implemented across all micro-size family product range to prevent recurrence.

10. Acknowledgements

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11. References

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