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Non-contact measurement and analysis of machine tool spindles

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With tolerances in production constantly reducing it is necessary to know the capabilities of machine tools. A major source of inaccuracy in machine tools is down to spindle errors. It is therefore the aim of this project to assess the effect of these errors on part production depending on machine and operation, with a view to enabling easier spindle checks and therefore predictive maintenance.

**INTRODUCTION**

**TECHNOLOGIES**

<table>
<thead>
<tr>
<th>Technology</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eddy Current Sensor</td>
<td>These work using a magnetic field to sense the distance to the target</td>
<td></td>
</tr>
<tr>
<td>Laser Displacement Sensor</td>
<td>These work using a high frequency laser triangulation to sense distance to the target</td>
<td></td>
</tr>
<tr>
<td>Capacitance Sensors</td>
<td>These work using an electric field to sense the distance to the target</td>
<td></td>
</tr>
<tr>
<td>Accelerometer</td>
<td>These usually use a piezoelectric material generating voltage proportional to acceleration</td>
<td></td>
</tr>
</tbody>
</table>

**Sources of Error**

- **Thermal Error**
  - Thermal expansion due to heat generated in the spindle bearings at high speeds is the most common source of error in machine tools.

- **Positional Error**
  - Bearing Vibration due to bearing wear / damage can cause a poor quality surface finish. The figure to the left shows spikes in noise at certain frequencies.

- **Non-Rigid Error**
  - Spindle Position in relation to the machine tool, including axial and radial errors. The figure to the left shows an out of roundness plot.

- **Geometric Error**

**Research**

**Non-Contact Measurement Technologies**

- **Spindle Bearings**
  - Types
  - Vibration Cause / Effect
  - Bearing Life

- **Non-Contact Measurement**
  - Technologies
    - Advantages
    - Disadvantages

**Conclusions**

The successful completion of this project will result in:

- A better knowledge of the capabilities of non-contact measurement technologies including measurement uncertainty in different environments, cost etc.
- A clearer understanding of the cause / effect of spindle bearing vibration.
- The ability to analyse machine tool spindles in industry in order to assess capability and predict maintenance requirements.

**Project Aim:** To increase spindle analysis efficiency and accuracy.