Cause of Drivetrain Failure:

Surface Roughness

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Surface Roughness

• Fluctuations in height over a given surface as compared with the ideal case

Gear Tooth Regions

• **Pitch** – Rolling contact
• **Addendum** – Sliding and rolling contact
• **Dedendum** – Sliding and rolling contact
Measurements

• Optical Profilometer
  – 0.469mm x 0.352mm
  – Over 300,000 height values
Export to MATLAB

• Features
  – De-spike extraneous values
  – Fill in points of no data
  – Plot data

• Calculations
  – Average Correlation Length
    – Randomness
  – Bearing Ratio
    – Probable wear of surface
## Calculations

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ra</td>
<td>Average of Height Values</td>
<td>[ R_a = \frac{1}{n} \sum_{i=1}^{n}</td>
</tr>
<tr>
<td>RMS (Rq)</td>
<td>Root Mean Squared</td>
<td>[ R_q = \sqrt{\frac{1}{n} \sum_{i=1}^{n} y_i^2}^{[3]} ]</td>
</tr>
<tr>
<td>Skewness</td>
<td>Asymmetry of Height Distribution</td>
<td>[ R_{sk} = \frac{1}{n R_q^3} \sum_{i=1}^{n} y_i^3 ]</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>“Spikiness” of Distribution</td>
<td>[ R_{ku} = \frac{1}{n R_q^4} \sum_{i=1}^{n} y_i^4 ]</td>
</tr>
</tbody>
</table>

Results
Conclusion

<table>
<thead>
<tr>
<th></th>
<th>Average Ra (μm)</th>
<th>Average RMS (μm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addendum</td>
<td>.077</td>
<td>.116</td>
</tr>
<tr>
<td>Middle (Pitch)</td>
<td>.085</td>
<td>.123</td>
</tr>
<tr>
<td>Dedendum</td>
<td>.166</td>
<td>.224</td>
</tr>
</tbody>
</table>

• Dedendum had twice the Ra and RMS of other regions
• Positive Kurtosis and Negative Skewness imply sharp crevices and a good bearing surface
Production Applications

• Low Ra and RMS values are ideal
  – Can potentially affect friction and wear

• An understanding of the effect of surface roughness on the life of a gear contact can help prevent failures of drivetrains and similar components.
  – Quantification is important

• Questions?