APPENDIX C

Analysis of Results from Minitab

Taguchi Analysis: SF versus OV, ON, WF, WA

Linear Model Analysis: SN ratios versus OV, ON, WF, WA

Estimated Model Coefficients for SN ratios

<table>
<thead>
<tr>
<th>Term</th>
<th>Coef</th>
<th>SE Coef</th>
<th>T</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-7.28194</td>
<td>0.2557</td>
<td>-28.475</td>
<td>0.000</td>
</tr>
<tr>
<td>OV 4.00</td>
<td>-0.07814</td>
<td>0.2557</td>
<td>-0.304</td>
<td>0.792</td>
</tr>
<tr>
<td>ON 4.00</td>
<td>0.55099</td>
<td>0.2557</td>
<td>2.155</td>
<td>0.054</td>
</tr>
<tr>
<td>WF 2.00</td>
<td>-0.57300</td>
<td>0.2557</td>
<td>-2.241</td>
<td>0.047</td>
</tr>
<tr>
<td>WA 4.00</td>
<td>-0.05259</td>
<td>0.2557</td>
<td>-0.206</td>
<td>0.841</td>
</tr>
</tbody>
</table>

S = 1.023  R-Sq = 47.1%  R-Sq(adj) = 27.8%

Analysis of Variance for SN ratios

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Seq SS</th>
<th>Adj SS</th>
<th>Adj MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>OV</td>
<td>1</td>
<td>0.0826</td>
<td>0.0826</td>
<td>0.0825</td>
<td>0.08</td>
<td>0.784</td>
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<tr>
<td>ON</td>
<td>1</td>
<td>4.8575</td>
<td>4.8575</td>
<td>4.8575</td>
<td>4.64</td>
<td>0.054</td>
</tr>
<tr>
<td>WF</td>
<td>1</td>
<td>5.2533</td>
<td>5.2533</td>
<td>5.2532</td>
<td>5.02</td>
<td>0.047</td>
</tr>
<tr>
<td>WA</td>
<td>1</td>
<td>0.0442</td>
<td>0.0442</td>
<td>0.0442</td>
<td>0.04</td>
<td>0.841</td>
</tr>
<tr>
<td>Residual Error</td>
<td>11</td>
<td>11.5103</td>
<td>11.5103</td>
<td>1.04639</td>
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<td></td>
</tr>
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<td>Total</td>
<td>15</td>
<td>21.7479</td>
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</table>

Unusual Observations for SN ratios

<table>
<thead>
<tr>
<th>Observation</th>
<th>SN ratios</th>
<th>Fit</th>
<th>SE Fit</th>
<th>Residual</th>
<th>St Resid</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>-9.097</td>
<td>-7.384</td>
<td>0.572</td>
<td>-1.713</td>
<td>-2.02 R</td>
</tr>
</tbody>
</table>

R denotes an observation with a large standardized residual.

Response Table for Signal to Noise Ratios

<table>
<thead>
<tr>
<th>Smaller is better</th>
<th>Level</th>
<th>OV</th>
<th>ON</th>
<th>WF</th>
<th>WA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-7.354</td>
<td>-6.731</td>
<td>-7.855</td>
<td>-7.335</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>-7.210</td>
<td>-7.833</td>
<td>-6.709</td>
<td>-7.229</td>
<td></td>
</tr>
<tr>
<td>Delta</td>
<td>0.144</td>
<td>1.102</td>
<td>1.146</td>
<td>0.105</td>
<td></td>
</tr>
<tr>
<td>Rank</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

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Taguchi Analysis: MRR versus OV, ON, WF, WA

Linear Model Analysis: SN ratios versus OV, ON, WF, WA

Estimated Model Coefficients for SN ratios

<table>
<thead>
<tr>
<th>Term</th>
<th>Coef</th>
<th>SE Coef</th>
<th>T</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-54.0837</td>
<td>1.579</td>
<td>-34.261</td>
<td>0.000</td>
</tr>
<tr>
<td>OV 4.00</td>
<td>3.1790</td>
<td>1.579</td>
<td>2.014</td>
<td>0.069</td>
</tr>
<tr>
<td>ON 4.00</td>
<td>-7.4914</td>
<td>1.579</td>
<td>-4.746</td>
<td>0.001</td>
</tr>
<tr>
<td>WF 2.00</td>
<td>-5.3894</td>
<td>1.579</td>
<td>-3.414</td>
<td>0.006</td>
</tr>
<tr>
<td>WA 4.00</td>
<td>0.6526</td>
<td>1.579</td>
<td>0.413</td>
<td>0.687</td>
</tr>
</tbody>
</table>

\[ S = 6.314 \] \[ \text{R-Sq} = 77.7\% \] \[ \text{R-Sq(adj)} = 69.6\% \]

Analysis of Variance for SN ratios

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Seq SS</th>
<th>Adj SS</th>
<th>Adj MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>OV</td>
<td>1</td>
<td>161.70</td>
<td>161.700</td>
<td>161.700</td>
<td>4.06</td>
<td>0.069</td>
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<tr>
<td>ON</td>
<td>1</td>
<td>897.94</td>
<td>897.943</td>
<td>897.943</td>
<td>22.52</td>
<td>0.001</td>
</tr>
<tr>
<td>WF</td>
<td>1</td>
<td>464.72</td>
<td>464.723</td>
<td>464.723</td>
<td>11.66</td>
<td>0.006</td>
</tr>
<tr>
<td>WA</td>
<td>1</td>
<td>6.82</td>
<td>6.815</td>
<td>6.815</td>
<td>0.17</td>
<td>0.687</td>
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<tr>
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<td>438.58</td>
<td>438.575</td>
<td>39.870</td>
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</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>1969.76</td>
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<td></td>
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</table>

Response Table for Signal to Noise Ratios

Larger is better

<table>
<thead>
<tr>
<th>Level</th>
<th>OV</th>
<th>ON</th>
<th>WF</th>
<th>WA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-50.90</td>
<td>-61.58</td>
<td>-59.47</td>
<td>-53.43</td>
</tr>
<tr>
<td>2</td>
<td>-57.26</td>
<td>-46.59</td>
<td>-48.69</td>
<td>-54.74</td>
</tr>
<tr>
<td>Delta</td>
<td>6.36</td>
<td>14.98</td>
<td>10.78</td>
<td>1.31</td>
</tr>
<tr>
<td>Rank</td>
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<td>1</td>
<td>2</td>
<td>4</td>
</tr>
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</table>

Regression Analysis: SF versus OV, ON, WF, WA

The regression equation is
\[ \text{SF} = 2.41 - 0.00321 \text{OV} + 0.0206 \text{ON} - 0.0226 \text{WF} - 0.0106 \text{WA} \]

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Coef</th>
<th>SE Coef</th>
<th>T</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>2.4072</td>
<td>0.2773</td>
<td>8.68</td>
<td>0.000</td>
</tr>
<tr>
<td>OV</td>
<td>-0.003208</td>
<td>0.006902</td>
<td>-0.46</td>
<td>0.651</td>
</tr>
<tr>
<td>ON</td>
<td>0.020595</td>
<td>0.009860</td>
<td>2.09</td>
<td>0.061</td>
</tr>
<tr>
<td>WF</td>
<td>-0.02256</td>
<td>0.01062</td>
<td>-2.13</td>
<td>0.057</td>
</tr>
<tr>
<td>WA</td>
<td>-0.01063</td>
<td>0.03451</td>
<td>-0.31</td>
<td>0.764</td>
</tr>
</tbody>
</table>

\[ S = 0.276077 \] \[ \text{R-Sq} = 45.5\% \] \[ \text{R-Sq(adj)} = 25.7\% \]

Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>4</td>
<td>0.70042</td>
<td>0.17510</td>
<td>2.30</td>
<td>0.124</td>
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<tr>
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<td>0.07622</td>
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</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>1.53882</td>
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</tr>
</tbody>
</table>
Regression Analysis: MRR versus OV, ON, WF, WA

The regression equation is

MRR = 0.00021 - 0.000156 OV + 0.000382 ON + 0.000200 WF - 0.000019 WA

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Coef</th>
<th>SE Coef</th>
<th>T</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.000215</td>
<td>0.002306</td>
<td>0.09</td>
<td>0.927</td>
</tr>
<tr>
<td>OV</td>
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<td>0.00005741</td>
<td>-2.71</td>
<td>0.020</td>
</tr>
<tr>
<td>ON</td>
<td>0.00038225</td>
<td>0.00008202</td>
<td>4.66</td>
<td>0.001</td>
</tr>
<tr>
<td>WF</td>
<td>0.00019985</td>
<td>0.00008832</td>
<td>2.26</td>
<td>0.045</td>
</tr>
<tr>
<td>WA</td>
<td>-0.0000185</td>
<td>0.0002871</td>
<td>-0.06</td>
<td>0.950</td>
</tr>
</tbody>
</table>

S = 0.00229645  R-Sq = 75.7%  R-Sq(adj) = 66.8%

Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0.000045076</td>
<td>8.55</td>
<td>0.002</td>
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