Table 6.1: Comparison of quasi-analytically computed sensitivity derivatives, $\frac{dC_L}{d\beta_{10}}$, with finite-difference for the airfoil optimization.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Central Finite-Difference</th>
<th>Quasi-Analytic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.673452*</td>
<td>0.673451</td>
</tr>
<tr>
<td>2</td>
<td>1.17407*</td>
<td>0.826805</td>
</tr>
<tr>
<td>3 &amp; 4</td>
<td>1.17407*</td>
<td>1.17413</td>
</tr>
</tbody>
</table>

# First-order spatially accurate
* Higher-order spatially accurate

Table 6.2: Summary of the airfoil optimization results.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>$C_L^F$</th>
<th>$C_D^F$</th>
<th>Function Evaluations</th>
<th>Gradient Evaluations</th>
<th>CPU [Y-MP min]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.5931</td>
<td>0.03517</td>
<td>43</td>
<td>6</td>
<td>5.2</td>
</tr>
<tr>
<td>2</td>
<td>0.8123</td>
<td>0.02978</td>
<td>37</td>
<td>5</td>
<td>12.9</td>
</tr>
<tr>
<td>3</td>
<td>0.8744</td>
<td>0.02989</td>
<td>39</td>
<td>5</td>
<td>18.4</td>
</tr>
<tr>
<td>4</td>
<td>0.8744</td>
<td>0.02989</td>
<td>39</td>
<td>5</td>
<td>23.6</td>
</tr>
</tbody>
</table>

$F \equiv$ Final Optimized

Table 6.3: Summary of the multielement airfoil optimization results.

<table>
<thead>
<tr>
<th>Initial Objective</th>
<th>Final Objective</th>
<th>Function Evaluations</th>
<th>Gradient Evaluations</th>
<th>Memory† [MW]</th>
<th>CPU Y/MP‡ [hr]</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.792</td>
<td>4.028</td>
<td>82</td>
<td>7</td>
<td>2.67/4.18</td>
<td>0.062/0.675</td>
</tr>
</tbody>
</table>

† Memory for CFD analysis/memory for sensitivity analysis.
‡ CPU time for converged CFD analysis/total optimization run time.