16.810   **IAP 2005**
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Data Analysis Protocol

This systematic walkthrough is accompanied by a sample excel spreadsheet available in the projects section.

This is the correct calibration matrix equation (ignore the matrix given in the original protocol):

$$
\begin{bmatrix}
9.2758 & -0.177 & -0.0589 & -0.1796 \\
0.2977 & 9.1166 & 0.0861 & 0.0407 \\
0.2176 & -0.1894 & 18.2251 & 0.6773 \\
-0.1918 & 0.0131 & -0.0766 & 27.7896
\end{bmatrix}_{\substack{calibration \\ matrix}}
\times
\begin{bmatrix}
side \\
drag \\
lift \\
yaw
\end{bmatrix}_{raw}
=
\begin{bmatrix}
side \\
drag \\
lift \\
yaw
\end{bmatrix}_{calibrated}
$$

Copy the relevant raw data (velocity, side, drag, lift & yaw) into a new sheet in excel.

Multiply each item through using the equation above to get calibrated pounds-force.

To check your math, if you entered the following sample data point you would get the result shown:

$$
\begin{bmatrix}
0.208 \\
0.4190 \\
-3.0070 \\
1.5930
\end{bmatrix}_{\substack{raw\ data \\ point}}
\Rightarrow
\begin{bmatrix}
1.7462 \\
3.6877 \\
-53.7580 \\
44.4648
\end{bmatrix}_{\substack{calibrated \\ data \\ point}}
$$

I set up excel to show the calibrated data along side the raw data. Note that you do not need to calculate Side & Yaw, but you DO need to use the raw values of Side & Yaw to calculate your calibrated Lift & Drag.

Now is a good time to determine the weight of your apparatus. First, take the average of the lift for the data points before the wind tunnel was brought up to speed (with your airfoil attached to the load cell, this is labeled "Before" in the example). Then do the same thing for the data points after the wind tunnel was brought down to zero and you removed the airfoil (this is labeled "after" in the example). The difference between these two values should give you the weight of your apparatus in pounds force, which can be converted to Newtons (see the original protocol for this conversion).

Next, you must re-center your data about the nominal values of lift and drag. Find the average values for drag and lift for the period before the wind tunnel was brought up to speed (hint: you should have found the nominal lift in the previous step when you calculated the "Before" variable).

Take these nominal values and subtract/add them to your calibrated data. This should result in calibrated lift and drag measurements starting at zero. These are shown in the example under "English Units (lbs)". This can then be converted into metric units much the same way the weight was converted.

Now that you have your data in a useful form, you can take the average of the data points at 60 mph to determine operating down force and drag. Plug them into the objective equation along with the weight you calculated above. Make sure you do this final calculation in Newtons.