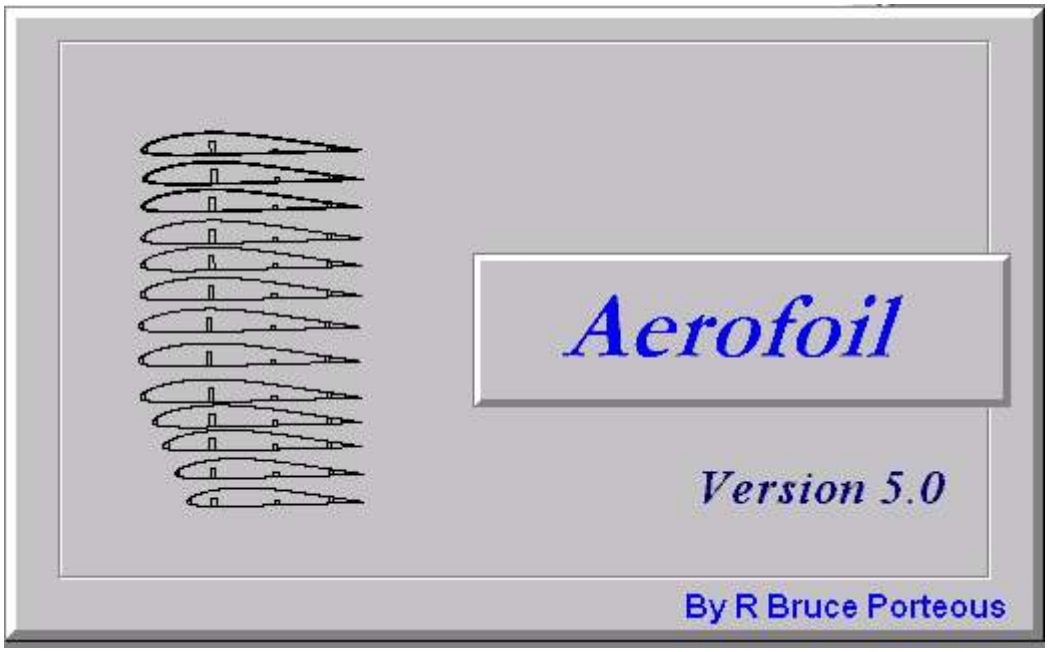
Aerofoil v5.0



By R Bruce Porteous

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Introduction

This program allows you to plot wing sections including spars, leading and trailing edges, and skins. It was first written a number of years ago, to run on an early PC-AT with MS-DOS. In this incarnation it's main function was to drive a CNC wing-cutter. That functionality is still part of the program although, when it was re-written to work under Windows, plotting and printing became it's main purpose.

Knowledge of the program's provenance is useful when you are using it to plot sections of a wing, a 3 dimensional object, on a 2 dimensional piece of paper. The basic principle is that you define the wing structure, at root and tip (as if you were defining templates for cutting a foam wing) and then plot sections of that structure. This makes tapered wings easy and there is no need for the root and tip sizes or sections to be the same: the program will interpolate between the root and the tip.

In addition to plotting wings it will also plot ellipses or half ellipses for formers. The same principle of defining 2 ends and taking sections along the resultant 3 dimensional object applies as for when you plot wings.

Finally, and this is only really of use when driving a CNC cutter, the program allows you to add waypoints which will guide the cutter between cores.

Installation

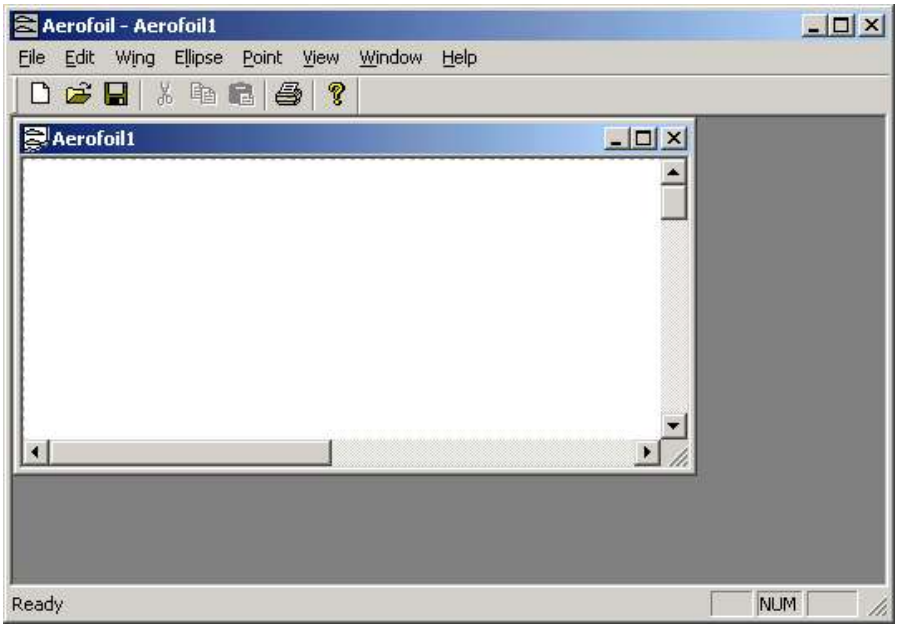
Simple – copy *aerofoil.exe* into a folder along with the data sub-directory (which contains the aerofoil sections) on to your hard drive. It doesn't matter where the folder is although it is usually a good idea to put it in a folder where all the users of the PC can access it.

If you want to create shortcuts to the program then point them to *aerofoil.exe* in whichever install folder you decided on.

Un-install is also simple – delete the program and its data files. There is no install or un-install program. If you created any shortcuts, delete them too.

Running

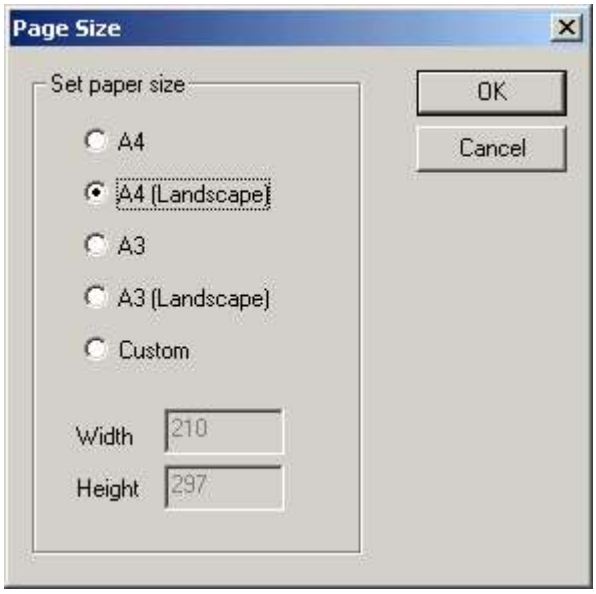
Open up the folder that contains *aerofoil.exe* and double-click it. The program should start and give you a blank sheet similar to the picture below.



Plotting a Wing

Set the Plot Size

Before doing anything else, it's a good idea to set the plot size that you're working with. Select *File/Plot Size* and enter the plot size into the dialog shown below.



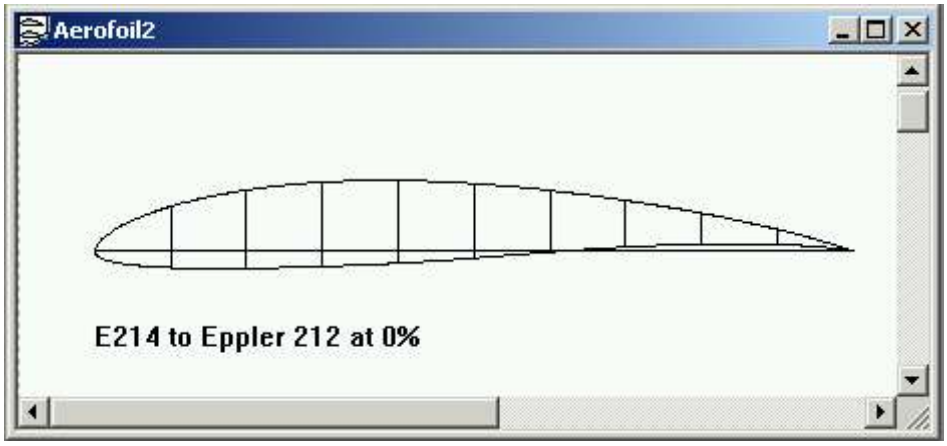
For normal printers, A4 landscape will normally be what you want.

Create the Structure

To create a new wing, select *Wing/New*. The program will pop up the standard file-open dialog.

This is to allow you to select the root section. Select the data (.DAT) file with the section coordinates for the root. If this is the first time you'll need to navigate to the data folder where all the coordinate files are stored. As soon as you close the first file-open dialog, another one pops up to allow you to enter the tip section.

You should then see the plot of the root section of the wing as shown below.

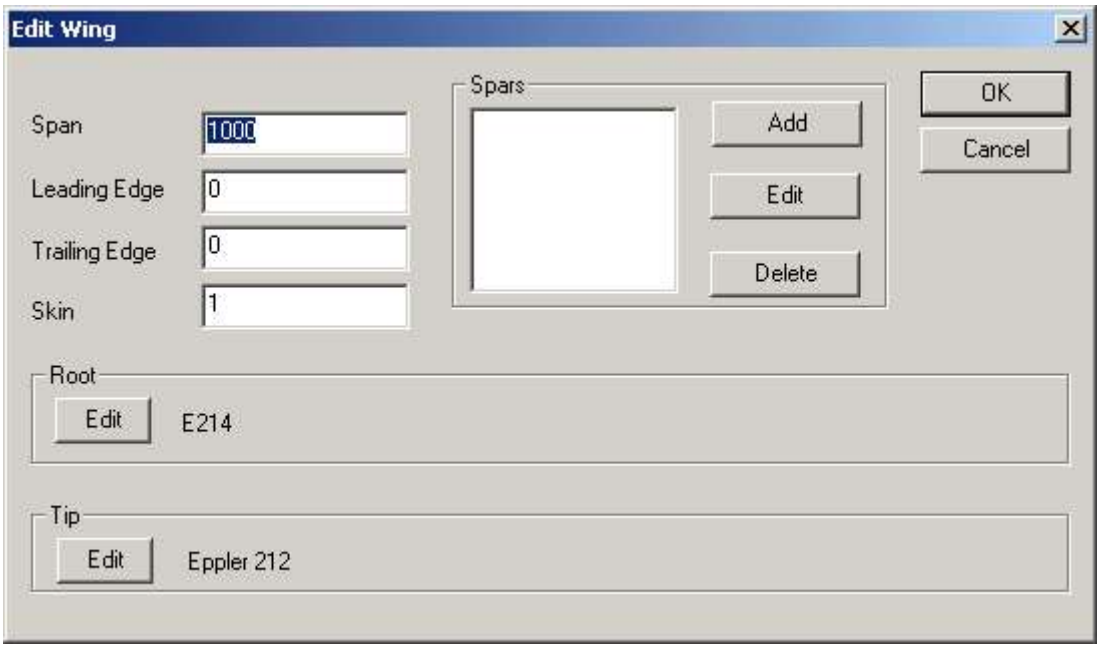


Note that the program in this case has plotted:

- The wing section itself at a default chord of 100mm
- The chord-line
- 10% markers (useful for manually cutting foam cores)
- A label including where the section is taken on the wing.

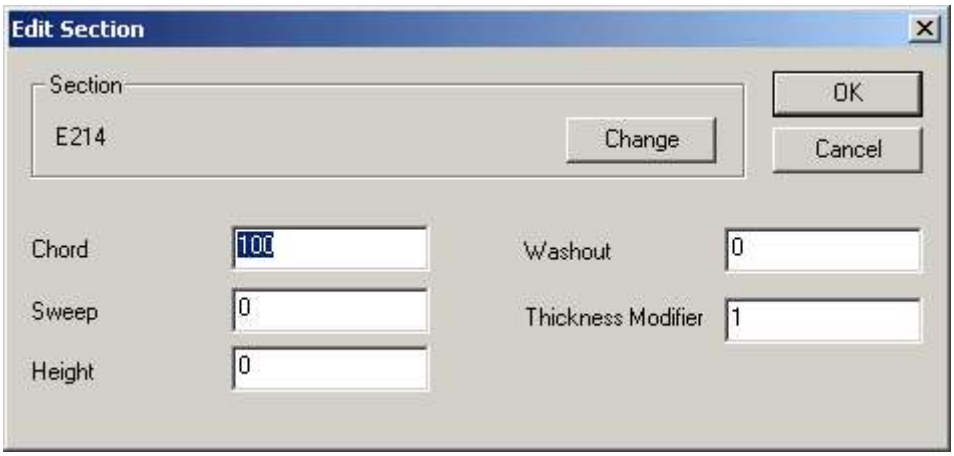
Exactly what's plotted depends on various settings.

Now, that's probably not what you want. In particular the chord size is almost certainly wrong. To change this you need to edit the basic wing structure. Highlight the section by clicking on it (it should go gray) and either select *Wing/Edit* or right click and select *Edit Wing*.



The *Edit Wing* dialog is shown above. This allows you to edit the basic geometry of the wing, including the (half) span, the size of leading and trailing edges, root and tip section and size and spars.

Let's change the root parameters – in the "Root" box, click on *Edit*. You'll see a dialog like the one shown below. You can change the section with the *Change* button but here we want to change the chord to (say) 200mm.

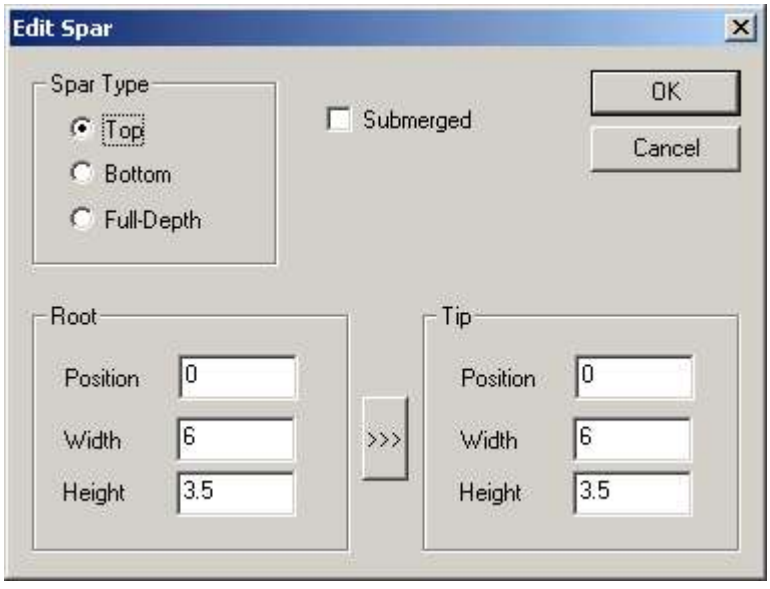


It's worth looking at the other parameters. For plotting on paper the *Thickness Modifier* entry is probably the most useful. This changes the thickness of the section. For example a *Thickness Modifier* of 1.2 will make a 10% thick section into a 12% thick section.

The other parameters: *Sweep*, *Height* and *Washout* allow the position and angle of the section to be changed. Not so important for plotting on paper but essential if it's driving a CNC cutter.

So, now that the basic geometry is set up let's add some structure. First we'll add a ¼ inch leading edge and a ¾ inch trailing edge. The program only accepts dimensions in mm so enter 6.3 for the leading edge and 19 for the trailing edge. Let's also define a skin thickness of 1/16 inch or 1.5mm. The next step is to add some spars.

In the spars box, click on *Add*. You should see the spar dialog shown below.



This allows 3 types of spar – top surface, bottom surface or full-depth. “Submerged” determines whether the spar is flush with the surface of the wing or is submerged under the skin. Usually if you've got a balsa skin you'll want a submerged spar. You also need to specify the position and size of the spar at its root and its tip (the position is the distance in mm from the leading edge) A short-cut is to use the “>>>” button to copy the root settings to the tip.

Any number of spars can be entered and they are displayed in a list in the spars dialog.

Select Sections to Plot

Once you've set up the wing structure you can plot multiple sections from that wing.

Click on an existing section of the wing to select the wing you want to plot a section of. Then select *Wing/New Section* from the menu bar. You'll get a dialog asking for the section's position:

This gives the position, in mm, of this section from the root. One of the parameters of the wing definition is *Span*. The position, relative to the wing's span parameter determines where the section is interpolated.

When you click on *OK* in the Section Position dialog the program will draw another section. You can then click on it's outline to select it and drag it to a new position on the drawing.

Tip: It's useful having a spreadsheet with all the rib positions if you're doing multiple ribs.

Plotting Cores

As well as the full structure of the wing sections the program will also plot templates for foam wings. If you've got a CNC cutter it can send coordinates to the cutter to cut them as well!

Select *Wing/New Core* from the main menu. The program will draw a core on the drawing, drag it to where you want it. You can change it's position on the span by right clicking it and selecting *Position*.

Modifying the Plot

Once you've set up a drawing you can modify what's there and how it's drawn. Firstly, anything on the drawing can be moved by dragging with the mouse.

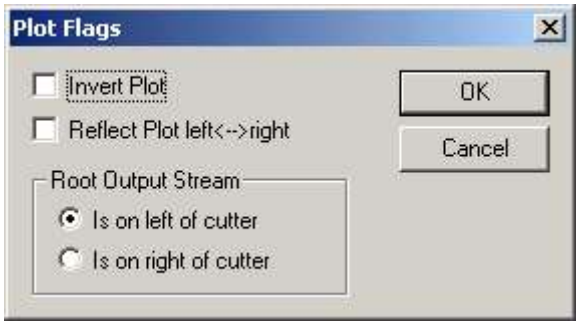
Secondly, there are flags that control exactly what in a wing (or ellipse) is drawn. These affect all the sections of that wing. Select the section of the wing or ellipse and, either right click it and select *Wing Flags* (for a wing) or, select *Wing/Flags* from the main menu. You'll get a dialog that specifies a number of options:

Most of these are fairly obvious. Markers are 10% markers for cutting foam cores by hand. Section determines whether the section is interpolated or both the root and tip are plotted. (you don't want interpolation if you're driving a CNC cutter).

The dialog for an ellipse is simpler:

It allows you to specify plotting only the top or bottom halves as well as center markers.

Thirdly, you can control some things per-section. Select the section with the mouse and either right click it and select *Plot Flags*, or, select *Edit/Plot Flags* from the main menu. You'll see a dialog like the one below:



Here, *Invert Plot* and *Reflect Plot left <--> right* allow you to flip the section vertically or horizontally respectively.

The *Root Output Stream* setting is really for a CNC cutter to allow you to switch which end of the cutter cuts the root.

Loading and Saving

Drawings can be loaded and saved. On the *File* menu:

- *New* creates a new drawing.
- *Open* opens an existing (.plt) drawing file.
- *Close* closes the current drawing.
- *Save* saves the current drawing to file.
- *Save As* saves the current drawing to file with a new filename.

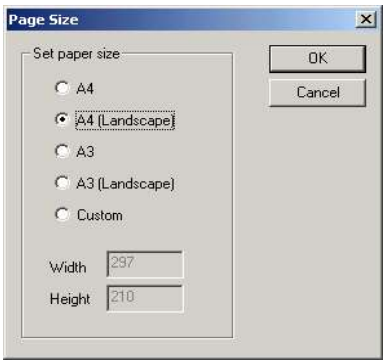
It's worth noting that the save format is XML. There is no schema per se, but looking at saved files will give a good guide. These files can be edited by hand if necessary although it's not usually necessary. Once instance where this may be necessary is if the aerofoil data (.dat) files are moved so the saved drawing files no longer reference valid aerofoil files.

Printing and Export

Printing

It's generally a good idea to set the plot size to match your printer:

File/Set Plot Size gives you the dialog shown below.



This caters for normal paper sizes and alignments but does allow you to set a custom size as well. The program draws a dotted rectangle around the selected plot size on the screen. Use this as a guide to the printable area – you can drag objects across these lines but they won't get printed.

File/Print and *File/Print Preview* work as you'd expect with the usual windows dialogs.

Export

As well as printing, Aerofoil can export data in a number of formats: DXF, Laser Jet and Postscript.

DXF

DXF allows you to export sections to be imported into Computer Aided Design (CAD) packages. Aerofoil is itself a CAD program – but a special purpose one. Most general purpose CAD packages will import DXF. To export as DXF select *File/DXF Output* and enter the name of the file to export to in the Save As dialog that pops up.

Postscript

It may be that you have access to a postscript printer, or want to send a file to someone else who has one. Aerofoil allows export in native postscript. Apart from allowing plot files to be saved and printed later, the postscript asks the printer to generate lines as thin as possible.

To export as Postscript, select *File/Postscript Output* and enter the name of the file to export in the Save As dialog that pops up.

Note that if you save a postscript file then the usual way to print it is to copy it to the printer device (e.g. PRN:) not to print it as a text file. Printing it as a text file will make the printer driver encode the Postscript with another layer of Postscript which will waste an awful lot of paper!

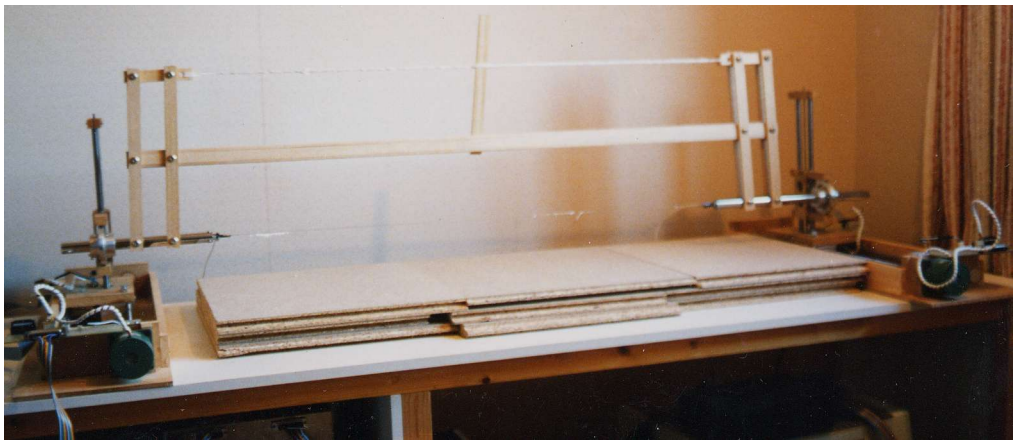
LaserJet

In a similar fashion to generating Postscript, Aerofoil will also generate HP-PCL for printing to a Hewlett-Packard laserjet.

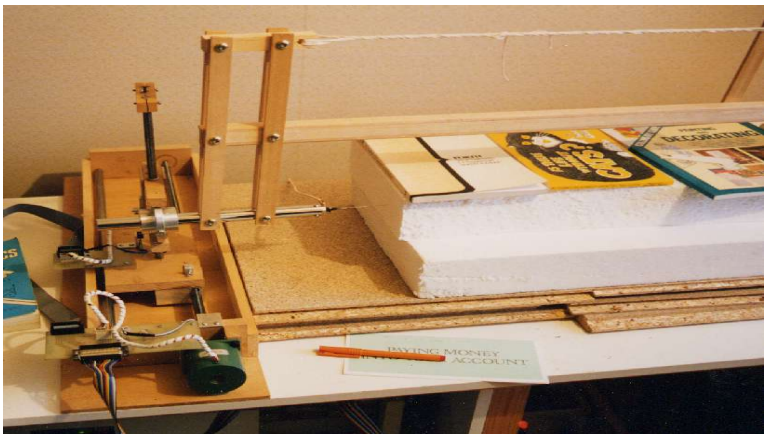
To export as HP-PCL, select *File/Laser Jet Output* and enter the name of the file to export in the Save As dialog that pops up.

CNC

We have the technology...



Or rather, we had the technology! Shown below cutting some cores.



Basically, the hardware needs 4 steppers and interfacing electronics. Aerofoil is set up to send the coordinates over TCP-IP to a cutter. It uses a simple form of XML where x & y coordinates are transmitted for root and tip. Cutter hardware and driver software is left as an exercise for the student.

Basically, if you want to try using this software to drive a cuttter, drop me an email – (bruce.porteous@ntlworld.com). There are a number of settings that need to be set up in the software including:

- Amount of melt-back
- Width of cutter
- Position of root and tip of block

Edit/Plot Order sets the order of plotting. Not important when printing, but fairly important when

cutting a foam core.

Zoom/Preview Cut Path previews the path a cutter would take. Note that the cutter program will be unresponsive while the preview is running.

Known Bugs

Preview cut path ignores any points and ellipses.

Not all the internal CNC settings are available to the user.