

Creating an Airfoil Mesh

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Abstract

Making a wing for YSFlight can be a challenging prospect for many new modders. Trying to incorporate the different moving parts like ailerons, flaps, spoilers, etc can be a lot to think about. But the beginning of a wing starts with the airfoil. Selecting an airfoil shape that will work well for your aircraft can make things a lot easier down the road when contemplating the moving parts of the wing.

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Introduction

While it is possible to create a fairly accurate model of an aircraft with incomplete references, it requires some understanding of aerodynamics and engineering. While entire books can and have been written regarding aircraft design and aerodynamics of wings and such, there are some basics that can be easily summarized in the following table:

Speed	Airfoil	Wing Area	Aspect Ratio
Slow	>15%	Large	High
Sub-Sonic	10-15%	Medium	Medium
Super-Sonic	<8%	Small	Small

Airfoils are often classified (as done here) by the ratio between their length and thickness. The larger the percentage, the thicker the airfoil. In general it is one of the simplest ways to determine if the airfoil is designed for slow or high speeds, and will be one of the main focuses in this guide.

1. Bezier Curve

You can quickly create airfoils using the Bezier Curve in Blender.¹ Before discussing how to form the airfoil, the basics of using the Bezier Curve must be covered. Insert a Bezier

¹There is a script for newer versions of Blender that can take airfoil coordinates and make airfoils, but they have too many vertices for YSFlight.

Curve by following Figure 1 from the add menu. It is useful to note that Bezier curves will be inserted into the model in the x-y plane. I recommend that you get the shape that you want in this plane and then rotate it into whatever position you want it to be in.

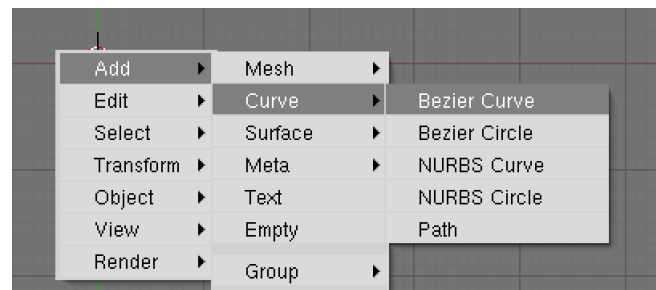


Figure 1. Make the animation for the selected object unique and unlinked from any other animation.

When you look at the Bezier Curve in Edit Mode, it looks weird. It looks like there are 6 vertices, three on each end, with some edges connecting each three. These are the control points for the Bezier curve. The center points on each end will control where the curve actually starts and ends, but the other points are used to shape the actual curve.

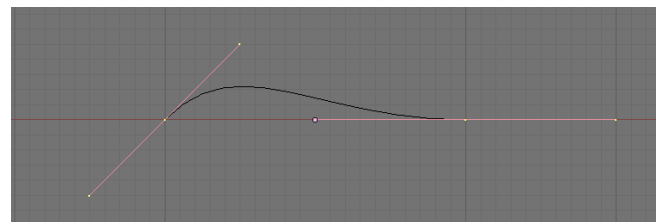


Figure 2. The Bezier Curve in Edit Mode.

Playing with the control points will help you understand how to achieve the shapes you want. You can read the Blender Wiki about Bezier Curves for more information, but for this tutorial we don't need anything more than knowing how to

change the shape of the curve. You don't even need to move the end points!

2. Forming the Airfoil Shape

It can take some fiddling to get this "just right" but looking at example airfoils can provide you with some great ideas as to what it should look like. See Section ?? for more information on where to find references.

2.1 The Upper Curve

The first step taken is to form the upper surface of the airfoil. Generally you want the highest point of this curve to be about 30-40 percent of the way from the leading edge to the trailing edge of the airfoil. You may also want to come back to this step later on once you have the bottom curve in place to fine-tune the upper curve.

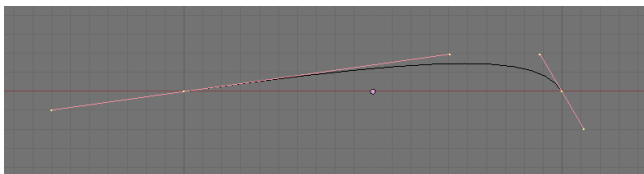


Figure 3. Forming the upper curve of the airfoil.

2.2 The Bottom Curve

To form the bottom curve there are several things that will make things easier for learning.

1. The two end points are coincident (in the same spot) as the upper curve
2. The end points of the airfoil are level.

Enter Object Mode and duplicate the upper curve. Be careful not to move the duplicated object.² Edit the duplicated curve and move the control points near the peak of the curve to below the horizontal axis, as shown in Figure 4.

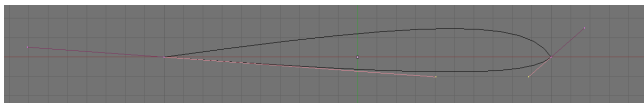


Figure 4. Forming the upper curve of the airfoil.

For the wing's airfoil, make sure that the bottom curve bulges less than the upper curve.³

²You can keep the duplicate but cancel the move by pressing escape while the duplicated object is still tracking your mouse movements.

³If you want a symmetrical airfoil for the aircraft's Vertical and horizontal tails, then lower curve of the airfoil will need to be the same distance below the horizontal as the upper curve is above it.

2.3 Leading Edge Editing

If you take a close look at the leading edge of the airfoil, you will see that it is rather pointy. A normal airfoil should have a smooth leading edge curve. Specialized high-speed airfoils will be more pointy, but for most applications the airfoil should have a rounded leading edge. In YSFlight, this also will allow you to have a smooth looking leading edge with no odd-looking crease running the length of the wing.

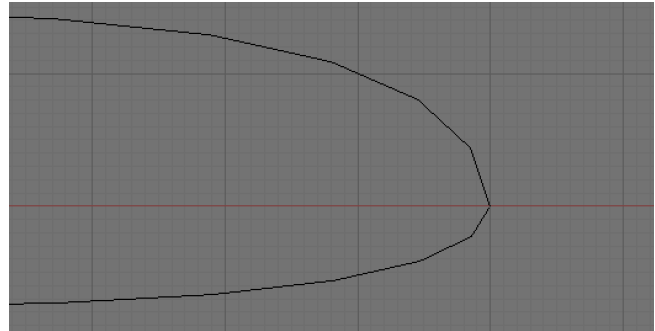


Figure 5. Forming the upper curve of the airfoil.

This can be accomplished by moving the forward control points near the curve peaks closer to the leading edge of the airfoil. Getting it close to the final shape as seen in Figure 5 will make the final touches easier to make.

2.4 Converting to Mesh

Now that the airfoil has been shaped you wish it to be, convert the curves to a mesh and join them together for form one final mesh object. If you need to make some adjustments to the leading edge, now is the time to do it. When you are ready to finalize the airfoil, select ONLY the leading edge vertices as seen in Figure 6 and remove the duplicates. This will remove any chance of a creased leading edge. If you remove duplicates on the trailing edge, then the sharp angle will create shading issues that will be more difficult to resolve later on.

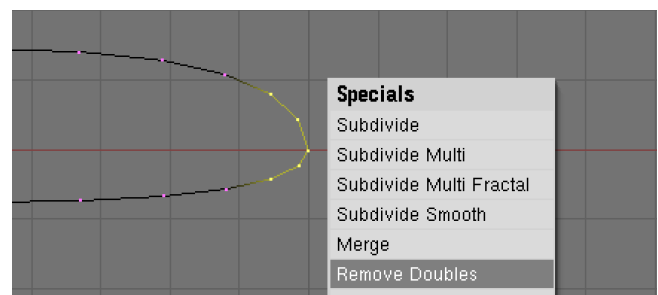


Figure 6. Forming the upper curve of the airfoil.

3. Final comments

Using the method of creating airfoils as shown in this document is certainly not the only way to make these complex

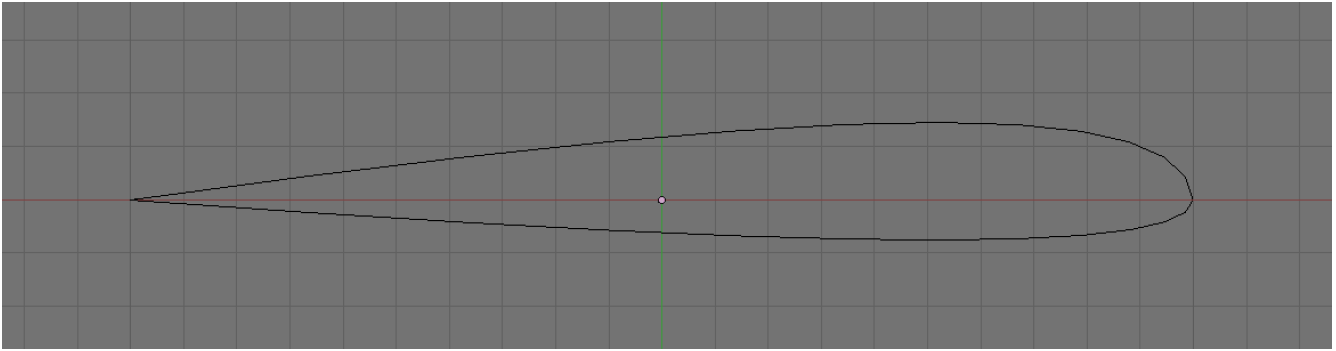


Figure 7. The final airfoil shape ready to be extruded into a wing.

shapes. Rather it is the quick and dirty method I use to get something that looks good and is fairly close to real life. The example airfoil that I created for this document is something generically tailored⁴ for a subsonic high-speed aircraft. Doing some basic research can go a long way to making a great looking model.

Whether you are making a scratch model, or updating an existing model with new details, a well defined airfoil can give you enough resolution to create wings with fully animated components. While the default resolution of a Bezier curve is 12 vertices, you can customize the detail on the airfoil by adding more vertices. You also have the option of reshaping the actual vertex positions after converting the curve to a mesh.

3.1 References

There are many different airfoils for different types of airplanes. Choosing the right type of airfoil for your airplane may require some research, however there are many great references. *The Incomplete Guide to Airfoil Usage*⁵ can show you the different types of airfoils used on common aircraft. While the actual airfoils may be proprietary information, the general shape can be estimated from other similar airfoils. Many airfoils in the *Airfoil Coordinate Database*⁶ will have previews that you can look at to see what they look like.

Acknowledgments

Thanks to all the contributors to the Blender 2.4 Manual.

⁴What an oxymoron!

⁵<http://m-selig.ae.illinois.edu/ads/aircraft.html>

⁶http://m-selig.ae.illinois.edu/ads/coord_database.html