

Mechanical characters

Mastering 3D Graphics ~ issue #2

Rhinoceros 3D ~ Ryan Knope

Introduction: The Story

In the year 2030 on the distant planet of Vergos 10, natural resources have dropped to an all-time low forcing the mining operations to go deeper than ever imagined before. Due to the pressure of the inner earth and explosive gasses at severely low depths, miners are not able to enter the bottom of the mines. This called for a new way to mine. Within a short period of time, mechanical units were assembled to explore and work in the mines. Each unit is controlled from a station above the surface in a virtual environment where the mech's eyes become yours.



Traits of Vergos 10 Dig Grappler

Let's check the general working conditions and the situations that this machine must endure. As with all machinery it is very heavy, and has crushing strength beyond belief. This is a mech that works in a mine, digging, moving, crushing and exploding the deep rock and metal within. It must be heavy and strong enough to lift thousands of pounds of material and make quick moves. The eyes in the forehead are also equipped with heavy-duty floodlights that change themselves when they become old. Each mech weighs a minimum of 40,000 pounds (20 tons) and stands 16 feet tall. This machine will need large claws to move objects, as well as a jack hammer-type tool to break objects apart. Large feet should be made to make this heavy mech stable

Concept Sketches

Concept sketches are very important. They let you plan your creature or object before modeling. This makes the whole process much quicker than before. How-

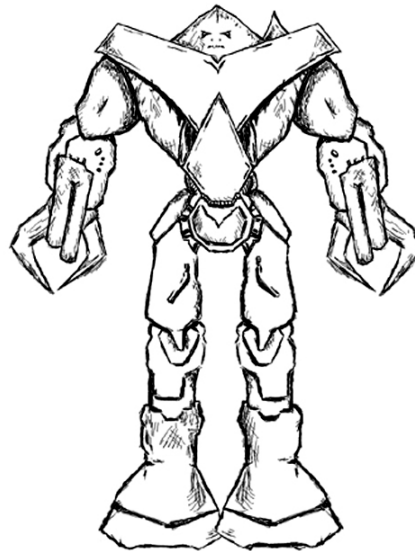


Figure 1

ever, you are not limited to what is in your concept sketch and you may go back and change it later. Many times you will create a few concept sketches and then combine certain things to plan out what you want. All in all, concept sketches are worth the time taken to make them. In [Figure 1](#) you can view the concept for the Vergos 10 Dig Grappler.

Modeling in Rhinoceros

Here is where most if not all of the work in this tutorial will take place. You will be making maps outside of Rhino, but basically you will use only Rhinoceros to model the

Vergos 10 Dig Grappler. In this tutorial, you will use a wide range of tools. Ranging from Loft and 2 Rail Sweeps to pipes and patches. You will use a variety of tools in Rhinoceros to model this mech and it will be of benefit for you to check out what each one does exactly in your user manual. This tutorial does not give all of the situations that these tools can be used in. [Figure 2](#) shows all buttons used in this tutorial.

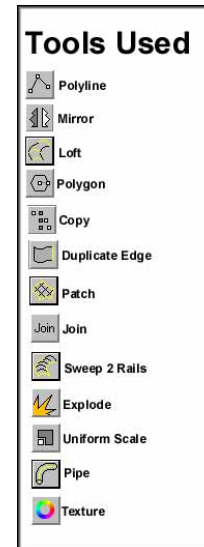


Figure 2

Modeling the Torso

To start the model we will begin with the torso by lofting splines. The type of splines that we use will be polylines. We will use polylines because they have a straight rigid edge that we want for our mech. It is quite hard to get a interpolated spline to look straight with sharp edges. The major downfall of using polylines is that they are un-editable once lofted, producing a polysurface which at this point in time, Rhino has no point or cv editing capabilities for. **Figure 3** shows a set of polylines drawn in Rhinoceros. I have used the right and front viewports to draw these. You should use the command Polyline to access this tool. Once these 5 splines are drawn you can mirror the middle front spline by using the Mirror command. **Figure 4** shows the process of mirroring the splines. You will have to click where you need the pivot to be. The pivot in this case is at the center of all the splines. **Figure 5** shows the aftermath of mirroring twice, once for each side.

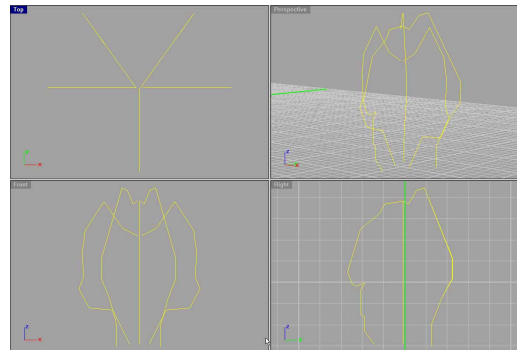


Figure 3

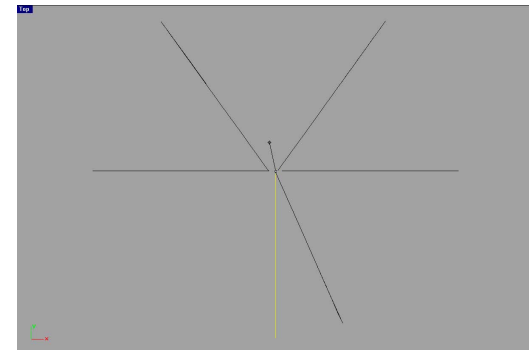


Figure 4

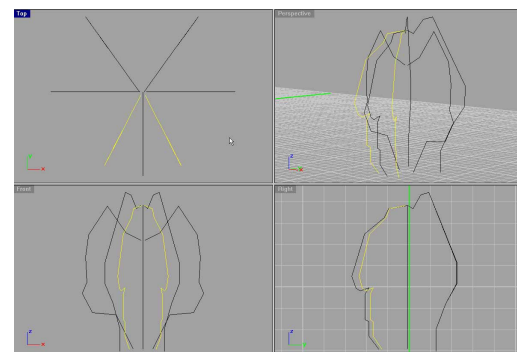


Figure 5

Now that you have all of the splines drawn, you can now choose the method for building a surface. There are several ways to do this but for what we have done so far in this situation, it would be best to use the loft tool. To access the Loft command simply type Loft in to the command line and press enter. You can either have all of your splines selected before entering this command, or select them after entering the command. Once your

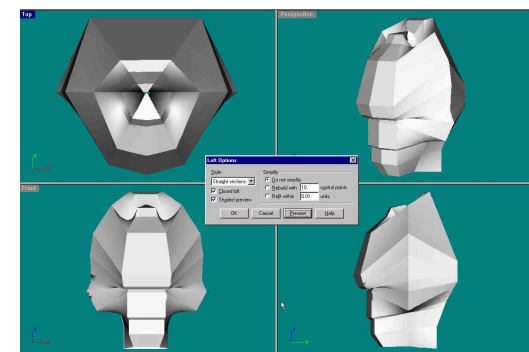


Figure 6

splines are selected, press enter and you should see a loft dialog box pop up. **Figure 6** shows the settings that have been used in this case. Below are some explanations on what the settings do in the loft dialog. The terms and buttons of the Loft Dialog Box do the following:

Closed Loft: closes the surface (in this case, we don't to use this).

Shaded Preview: when quick shade is activated, it shows the current loft in progress in a shaded view.

Do not simplify: uses the current set of points on a spline to determine where isoparms will be located.

Rebuild with **: rebuilds a surface using ** number of isoparms (** is a number you indicate).

Style: determines how your surface will be generated. Normal builds it with normal

tightness and so on, while straight sections build a surface with straight sections at each isoparm.

After completing the loft, you should have a renderable surface for the torso. Now we can proceed to model the lower body.

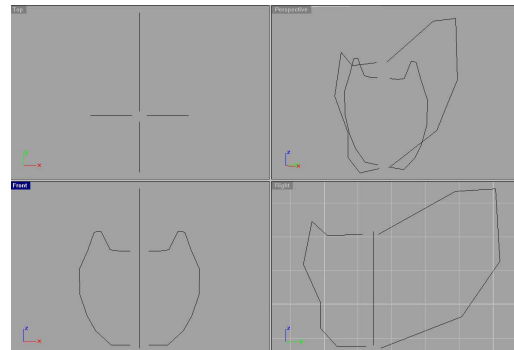


Figure 7

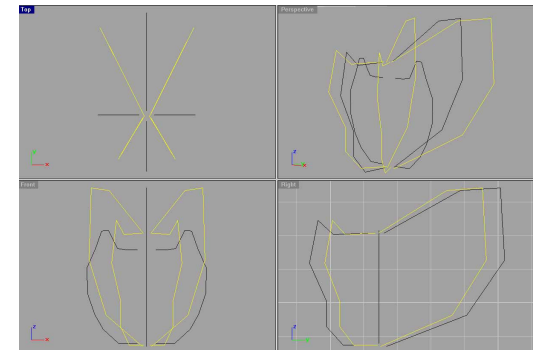


Figure 8

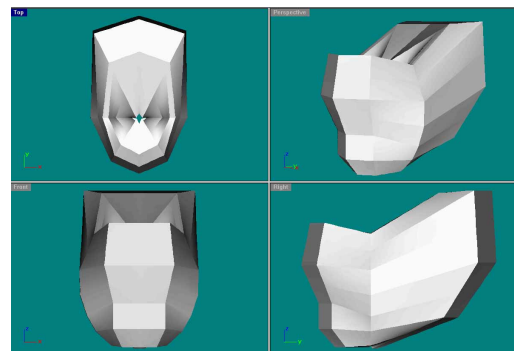


Figure 9

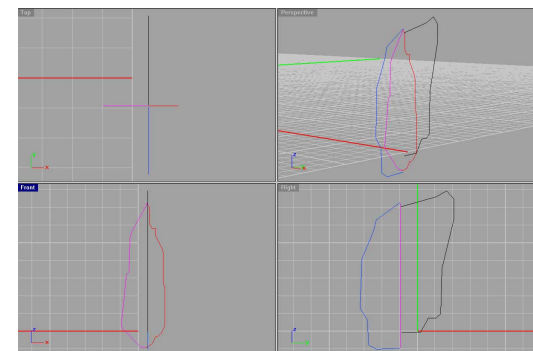


Figure 10

Lower body

Figure 7 shows the polylines drawn for the lower body. The front and back polylines now need to be mirrored just as you did for the upper body. In Figure 8 you will see the newly mirrored polylines along with the old ones. The mirrored polylines are in yellow to separate them from the father splines. You can now loft as you did on the upper torso. Figure 9 shows the output of the loft.

The Legs

For the legs, we will use the same method as before. Figure 10 shows the splines in different layers only to highlight the different polylines. In Figure 11, you can see the mirrored splines. The splines with the same color are mirrors of the same spline. In Figure 12 you can see the output of the loft. The loft is the same as you have previously done.

The calf is the next part to model. This will be modeled

just as the previous parts have been. Figure 13 shows the 4 Polyines in different layers. Figure 14 shows the mirrored curves in the same layers as the parent splines. Loft the curves to finish the calf. Use the previous settings.

Onto the Ankles of the mech. To model the ankles we will use the simplest type of loft there is; a polygon spline.

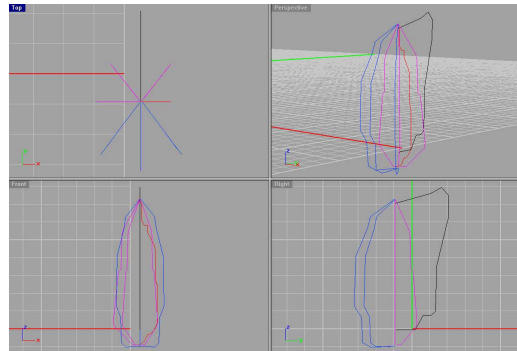


Figure 11

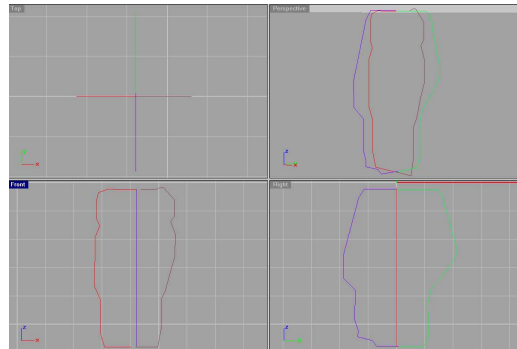


Figure 13

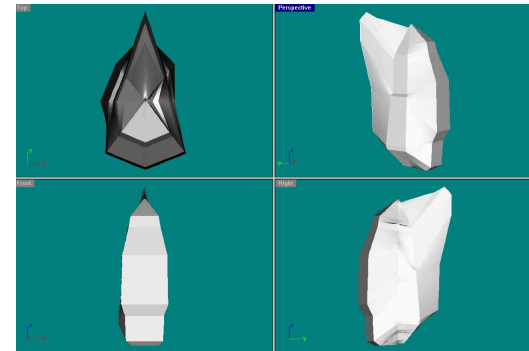


Figure 12

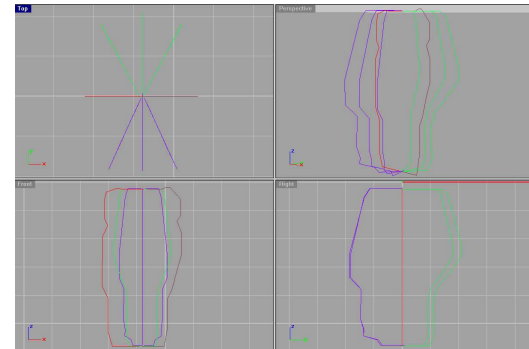


Figure 14

Simply type Polygon into the command line and press enter. At this point, the command line it will ask how many sides you want. For this project we will use 7 sides. Type in 7, then press enter and drag your polygonal spline out. After dragging out your polygon you should now copy it in a straight line. To do this use the command Copy and press shift as you drag your spline down. [Figure 15](#) shows the polygons that we have used and copied. Now select both splines and type ShowCV into the command line. This will show all the points or CV's that make up the splines. You can now edit the points by pulling them. In [Figure 16](#), you can see our edited splines. Now that you have completed the editing of the splines, you can now hide the points by using the command HideCV. Now loft by selecting both of your splines and typing loft into the command line. [Figure 17](#) shows the settings that have been used, as well as the output of the loft.

Lastly, on the leg we have the foot or boot area. This is a heavy balanced area so we must make it big. [Figure 18](#) shows the polylines drawn in different layers separating the different ones from mirrored ones. [Figure 19](#) shows the mirrored splines with the originals. [Figure 20](#) shows the loft dialog box for lofting the polylines for the boot. This is a different type of loft to the rest. This is a normal

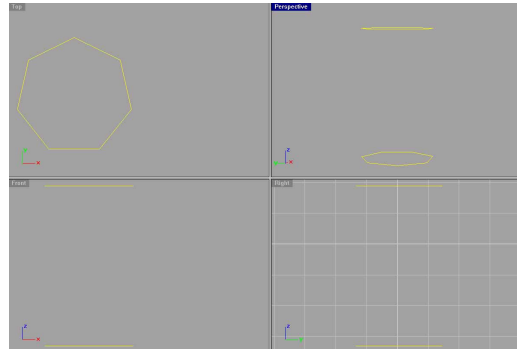


Figure 15

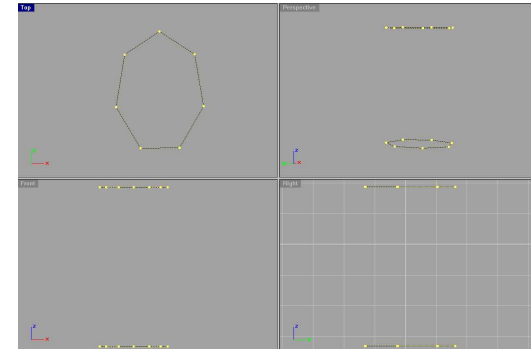


Figure 16

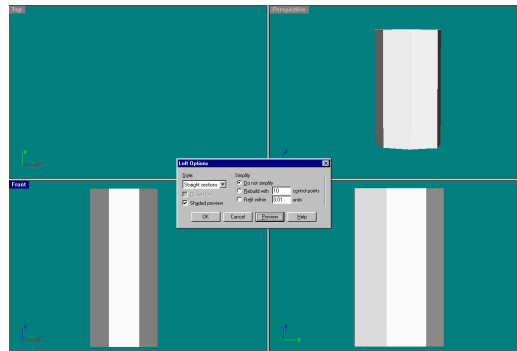


Figure 17

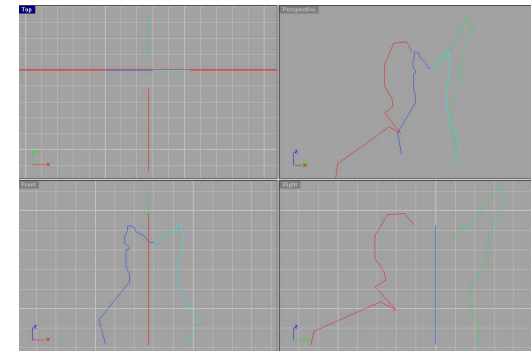


Figure 18

loft compared to the straight loft that we have been using. Now we must make the sole area of the boot. We will do this by extracting an edge of a surface using the DupEdge command. Figure 21 shows the edge that we have selected. If you used a straight loft, you would not be able to duplicate an edge. Copy the duplicated edge as shown in Figure 22. Now you can loft with the same properties as used when lofting the boot. With most of sole done, there is one thing left to finish it completely; a hole in the bottom of the shoe. Select the bottom spline of the sole and type Patch into the command line and press enter. Figure 23 shows the patch properties that have been used in this tutorial. Now join the bottom sole with the side that you previously did. To do this type Join into the command line and press enter. Then you need to select both sections and press enter.

We will now build a kneecap surface for the leg. Figure 24 shows all the splines used to

build the kneecap. Each mirrored spline is the same color as its parent. Loft the set of polylines with a straight loft and place near the kneecap area as seen in Figure 25.

Now you have a completed boot and leg. Mirror the leg models over across the mid-line of the torso. In Figure 26, the mid-line is shown. Figure 27 shows the Vergos 10 Dig Grappler at this point in the project.

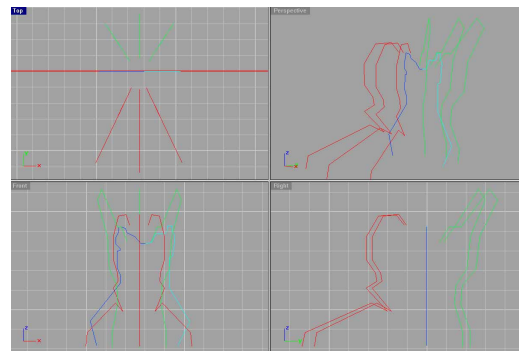


Figure 19

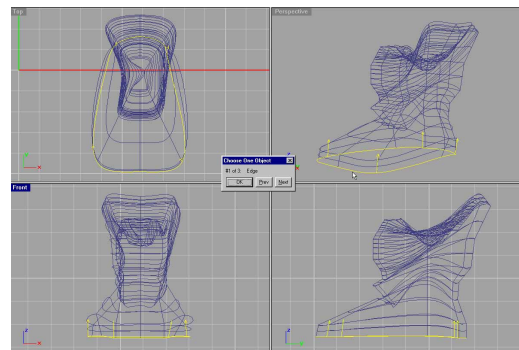


Figure 21

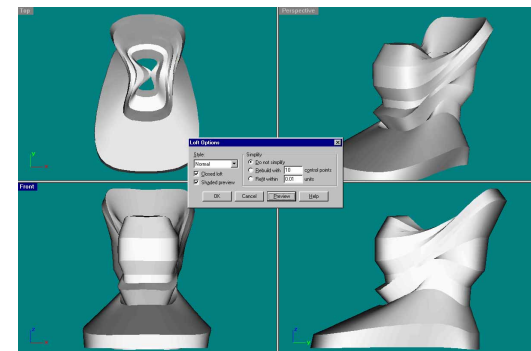


Figure 20

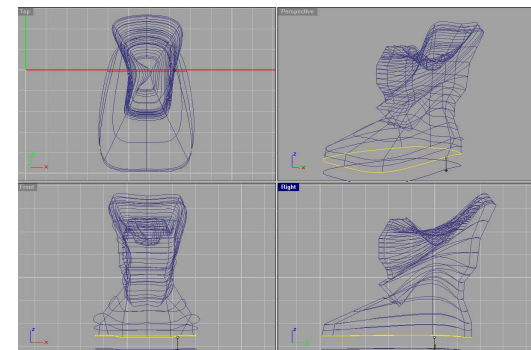


Figure 22

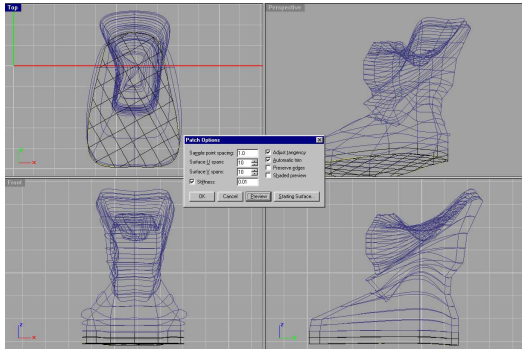


Figure 23

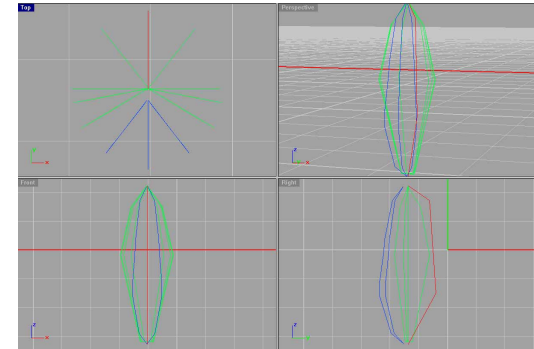


Figure 24

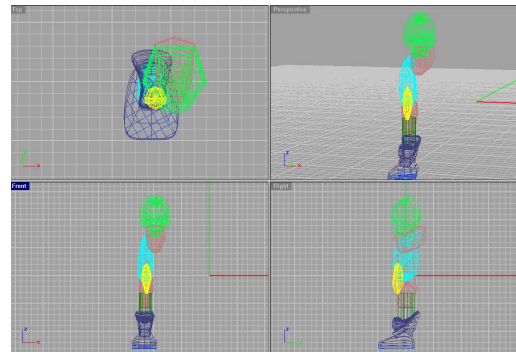


Figure 25

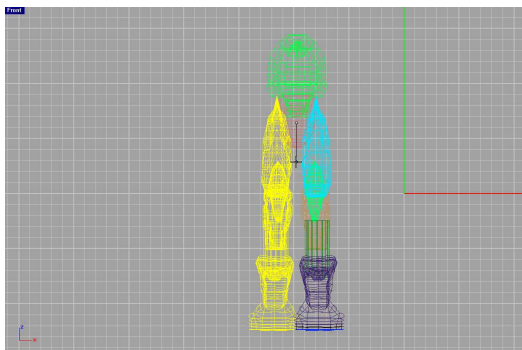


Figure 26

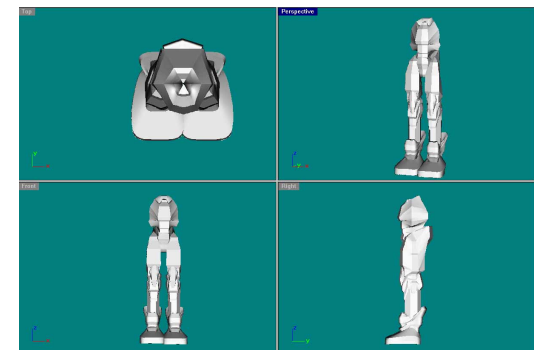


Figure 27

Shoulders and Arms

The shoulders and arms are next. We will use a few different methods of modeling on these parts. First, we will work on the shoulders, by using a 2 rail sweep. In [Figure 28](#) you will see 3 splines separated by color. One of these is a closed spline, the other two being open splines. The 2 open splines are the rail curves. Once these curves are drawn, you will need to access the 2 rail sweep tool by using the Sweep2 command. Press enter then select the 2 rail curves – as it asks you to – then select the closed spline and press enter. This should bring up a dialog box as seen in [Figure 29](#). This figure also shows the model that is produced

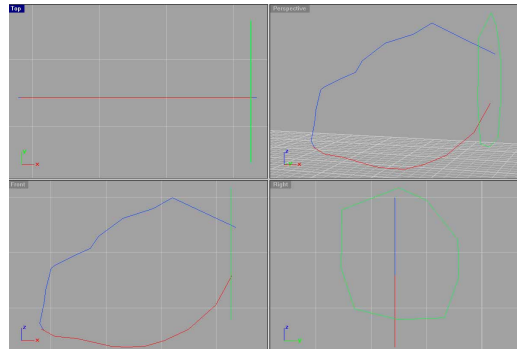


Figure 28

In [Figure 30](#), you can see 3 splines, two of which are the same. The other is a closed spline (a polygon). You will need to use 2 rail sweep to make this a surface. This is basically modeled the same way as the shoulders. [Figure 31](#)

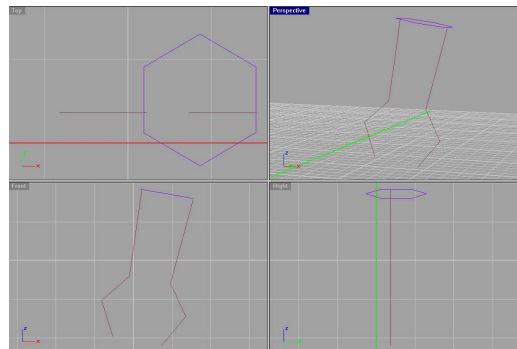


Figure 30

shows the output and the settings used. This is the upper arm.

[Figure 32](#) shows the beginning of the forearm. There are 3 splines... use the same method as above. We will now model the grippers. This is the final set of models for the basic arms. In [Figure 33](#), you can see 4 splines in 2 different colors. The splines in the same color are just

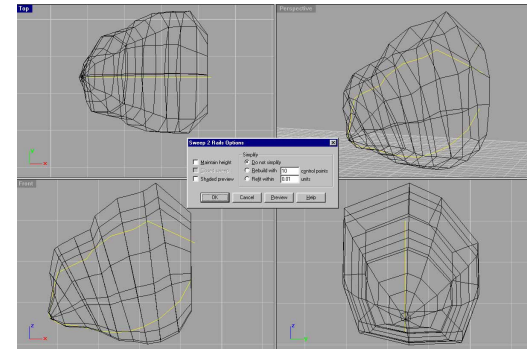


Figure 29

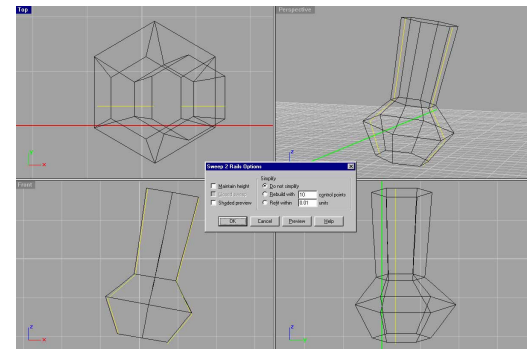


Figure 31

copied over using the command Copy. Now you must loft the splines in an open loft. [Figure 34](#) shows the details. You should have open ends on the surface now. You can fix this by selecting the outer spline and using the Patch command. Patch this one side at a time or it will not work. When using the Patch command, both surfaces remain editable. You can also use the Cap command on the surface to close all planar ends. Please be aware that if you use this command you will have to explode the object using the command Explode to edit the objects surfaces. You can now use Join to combine the surfaces, if you like. Next, you will need to mirror the gripper over to make a claw type look as seen in [Figure 35](#).

In [Figure 36](#), you can see the Vergos 10 Dig Grapppler thus far. You can see the idea of a strong looking mech with a heavysset base. Now we must move onto the head and finish the small details such as wires.

The Head

As with most things, you can produce a multitude of different details for the head. Many people prefer a sleek design and some prefer a more boxy shape. We will do one of each. First, we will start with a sleek bullet shaped head. In [Figure 37](#), you can see the splines drawn for the head; these are interpolated curves. The reason why you

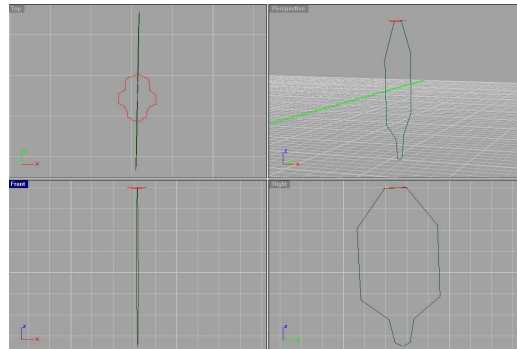


Figure 32

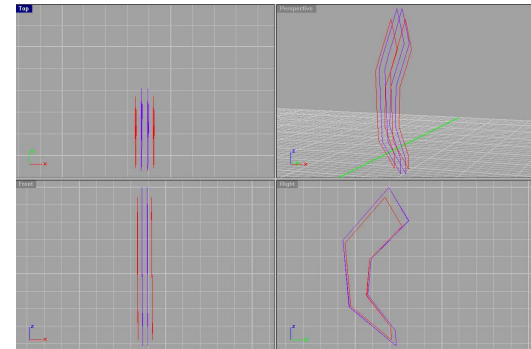


Figure 33

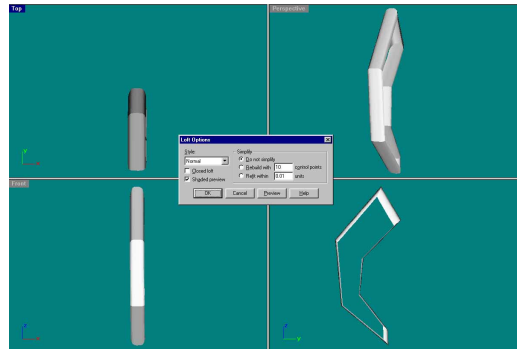


Figure 34

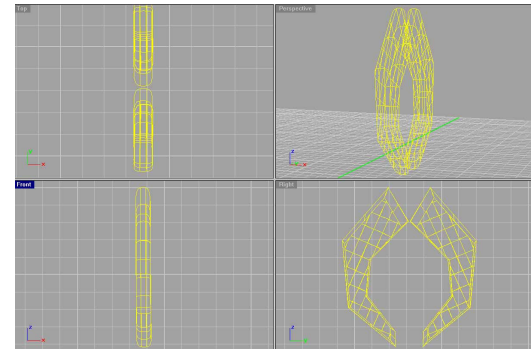


Figure 35

would use interpolated curves is because they define smoothness, where polylines do not. Splines of the same color are the same, just mirrored.

It would now be smart to zoom into the top poles of the head splines and check if they all come together at exactly the same point. This is important, because if they do not you will see either a small hole or a twisted spot on the surface. **Figure 38** shows the splines at the upper poles before editing. You can turn on points by using the command ShowCV. The easiest way to get points to be in a certain area is to use object or point snaps. For this surface, we will use point snaps. You can turn on point snaps by clicking the osnap button at the bottom of the application, as seen in **Figure 39**. This figure also shows the check at the point snap. This will make points snap at another point exactly. **Figure 40** shows the effect of point snap. You will notice a big difference in the loft compared to that if you

didn't use Point Snaps. Now loft the surface as a closed normal loft. You should get a result similar to **Figure 41**.

You can place this as a dome over where the head would go.

The boxy head will also use object (point) snaps

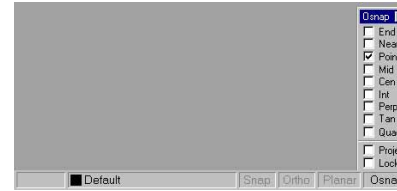


Figure 39

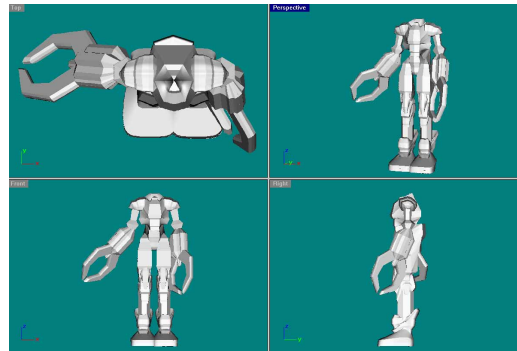


Figure 36

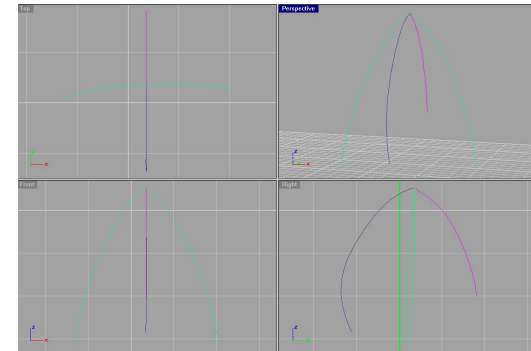


Figure 37

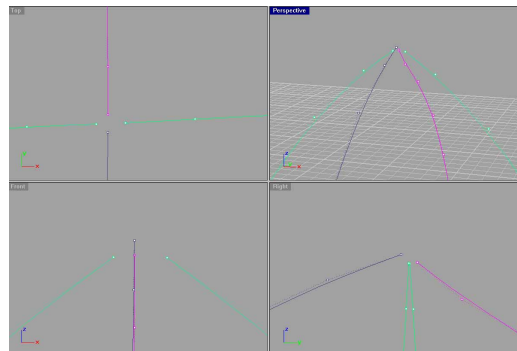


Figure 38

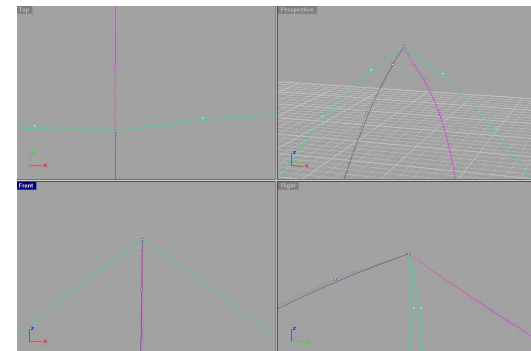


Figure 40

and will be modeled by lofting a set of splines as we have done before. This head will be started with all polylines. **Figure 42** shows the polylines used and mirrored. Once mirrored you can build the surface using a closed, straight section loft.

For the eyes, we will use a set of polygons (splines). **Figure 43** shows the polygons. The smaller set is scaled by a small amount. To scale them select the splines and use the command Scale. Now you can click and drag to the desired size. Use an open, straight section loft. Once lofted you will need to patch the edge splines. (If you deleted your edge splines you will need to redraw them to the exact size once again.) Use patch with the settings that were used previously in this tutorial. You have to do this for each side. Once finished you can now join the 3 surfaces using the join command.

In **Figure 44**, you will see how the eyes have been positioned. You can rotate objects using the

Rotate command. **Figure 45** shows the model that we have built so far. We are almost finished. The parts left are some wires and other small details that make a difference.

Small details that Make a difference

Small details can make a major difference in the way people look at your models and renders. In **Figure 46**,

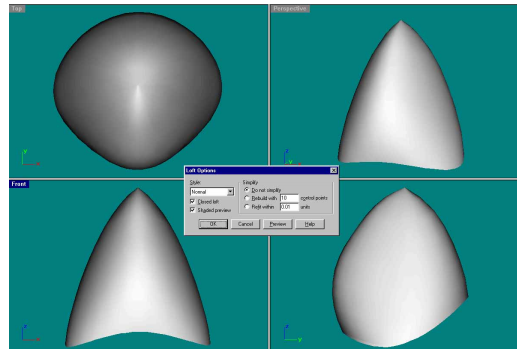


Figure 41

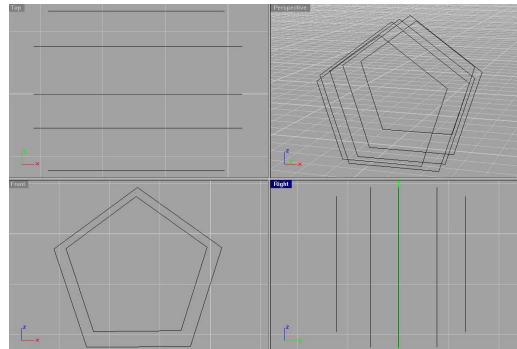


Figure 43

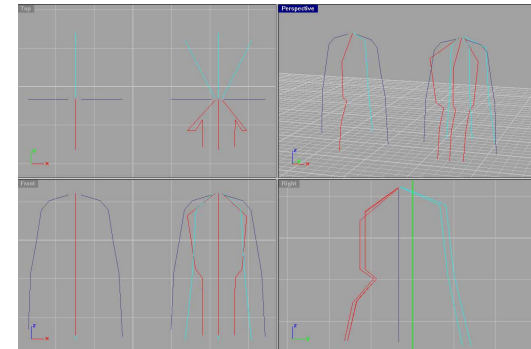


Figure 42

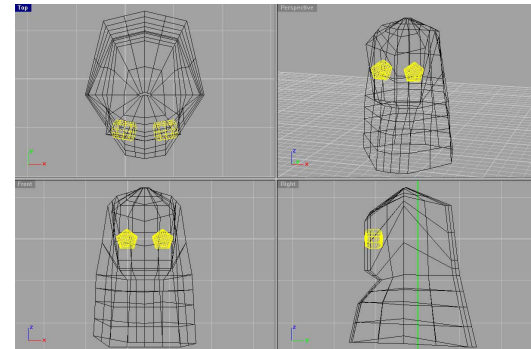


Figure 44

you can see a close up of the arm area with an interpolated spline. This will be used as a wire or cable near its arm region. You can make a solid surface out of this using the Pipe tool. Access this tool by typing Pipe into the command line and pressing enter. At the prompt for a pipe size you can either enter a keyboard command such as a size in numbers (we have used .07 as a radius) or you can draw the radius when the size prompt is shown in the command line.

Now that the wire has been finished it must connect to something, so we will make an input for it to connect to. **Figure 47** shows the polygon splines used in creating the input surface. Use a normal, closed loft to produce the surface shown in **Figure 48**. Small details such as these make a large difference in the reality of a character. There is of course, quite few more small details that could be added, but would make this tutorial endless.

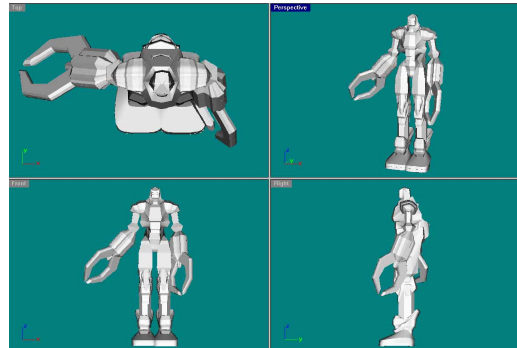


Figure 45

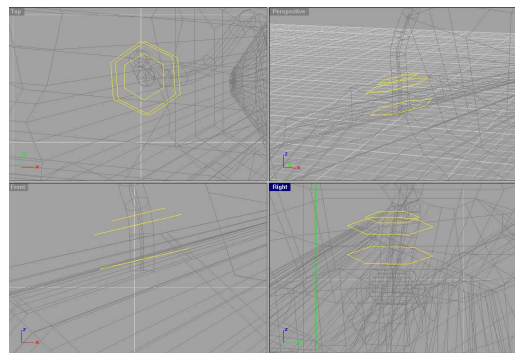


Figure 47

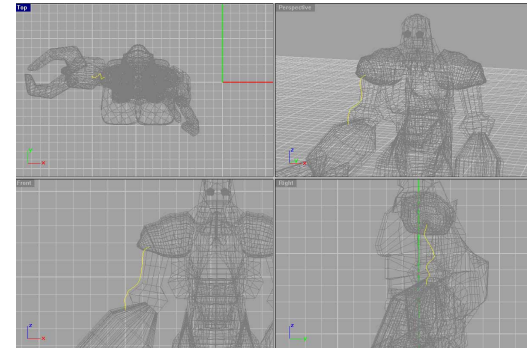


Figure 46

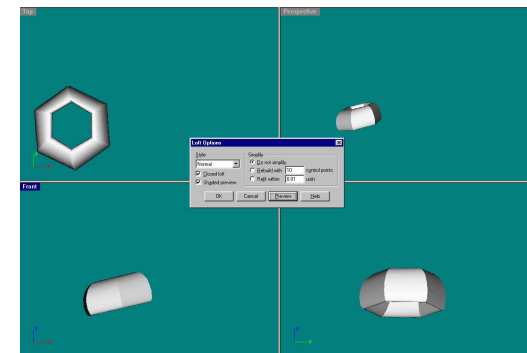


Figure 48

Surfacing

Rhinoceros 3D 1.0 does not support many surfacing features. For this reason, it would be wisest to surface your mech (or any other creature or object) in a separate application. With the release of 2.0, an open plugin interface is said to be on the list of new features to be intro-

duced. With this may come some very interesting options.

Rhinoceros does however offer the use of texture and bump maps, as well as transparency and highlight. These options are quite limited. If you need high quality renders use applications such as 3D Studio Max, Maya, or Lightwave. There are also many more standalone renders such as Pov-Ray or BMRT. Get Pov-Ray at www.povray.org for free. In Figure 49, you can see the final completed model.

Wrap up

Well, with this tutorial coming to a close, you can see how easy it is to model a mechanical character in Rhinoceros 3D. Whilst modeling this character you went over many of the tools available in Rhinoceros 3D 1.0. Working in Rhinoceros takes time and practice as

with any application, or anything in life in general. Keep modeling and be patient, because to some there is no greater reward or feeling than creating great computer graphics. If you're not there already then some day, you will be. Be patient and keep modeling in Rhinoceros.

If you have any questions about Rhinoceros 3D please feel free to e-mail me at ryan.knope@komodostudio.com. I would also be very pleased with any feedback on this tutorial.

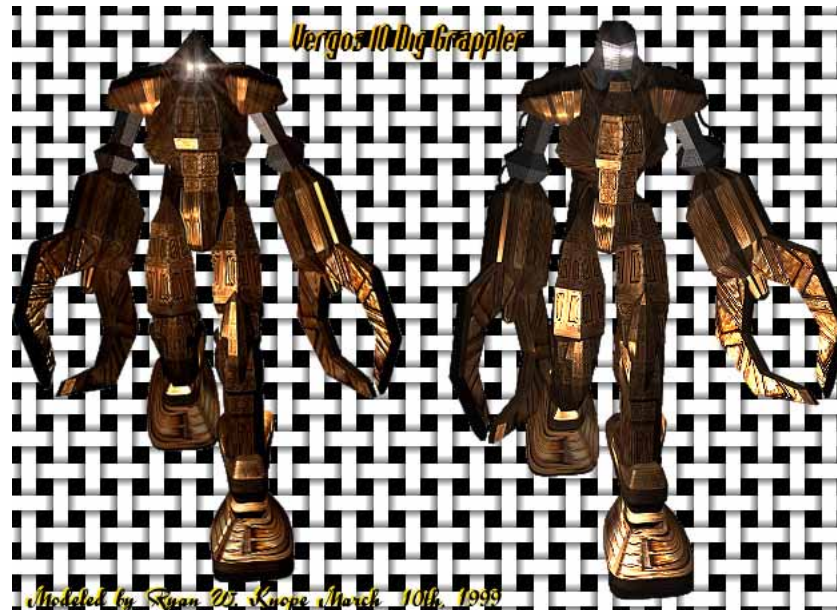
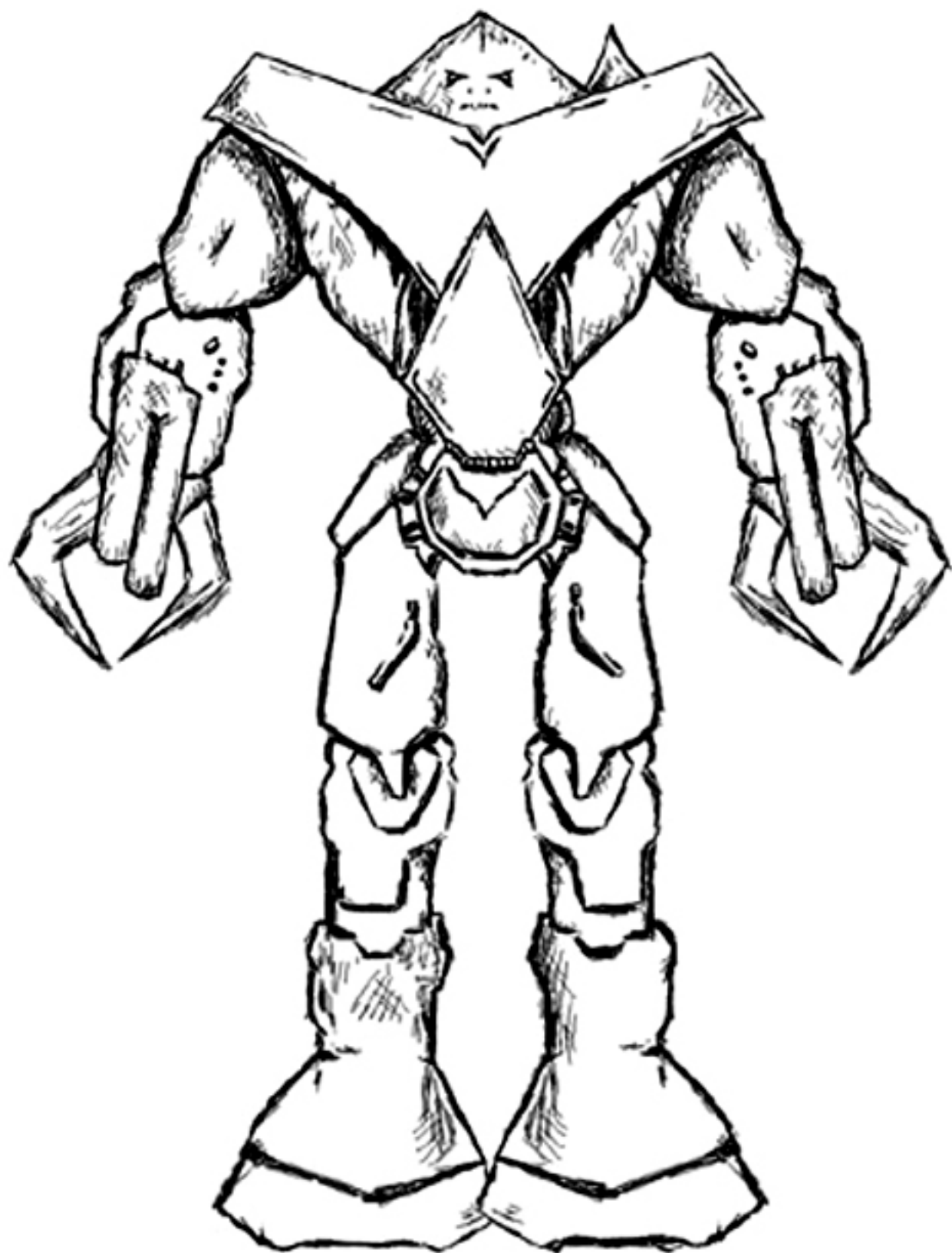


Figure 49

Vergos 10 Dig Grappler



Modeled by Ryan W. Knope March 10th, 1999



Tools Used



Polyline



Mirror



Loft



Polygon



Copy



Duplicate Edge



Patch



Join



Sweep 2 Rails



Explode



Uniform Scale

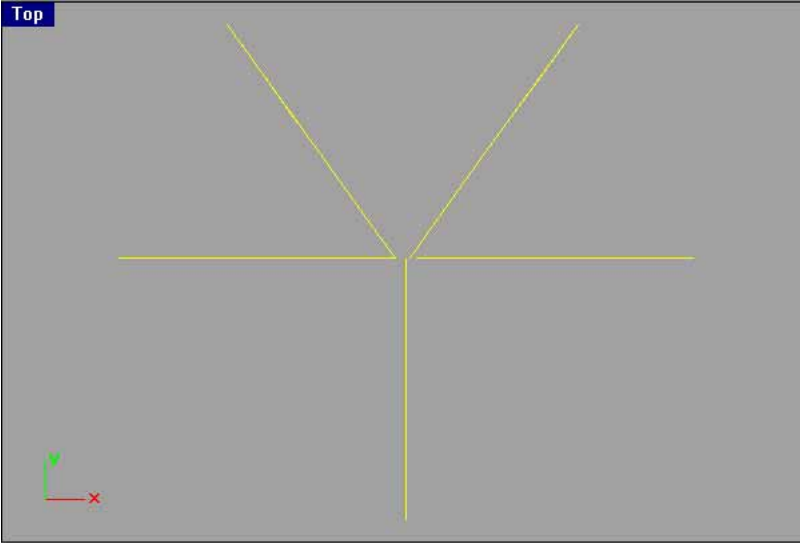


Pipe

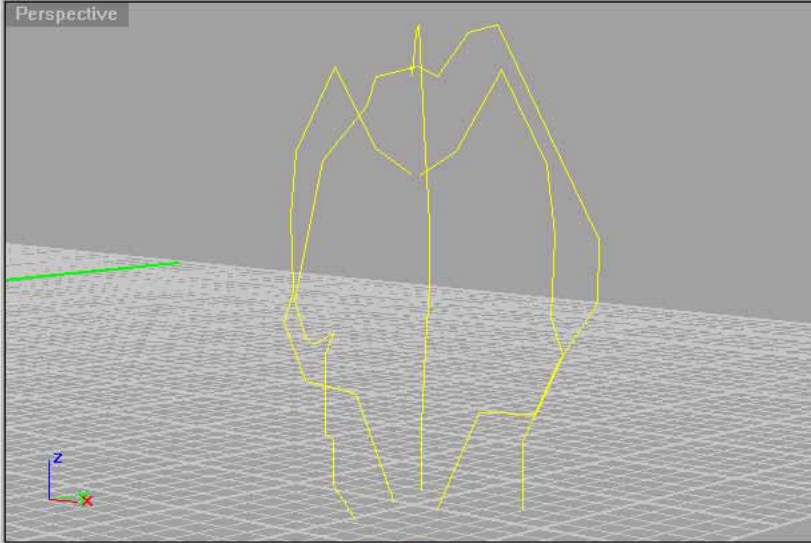


Texture

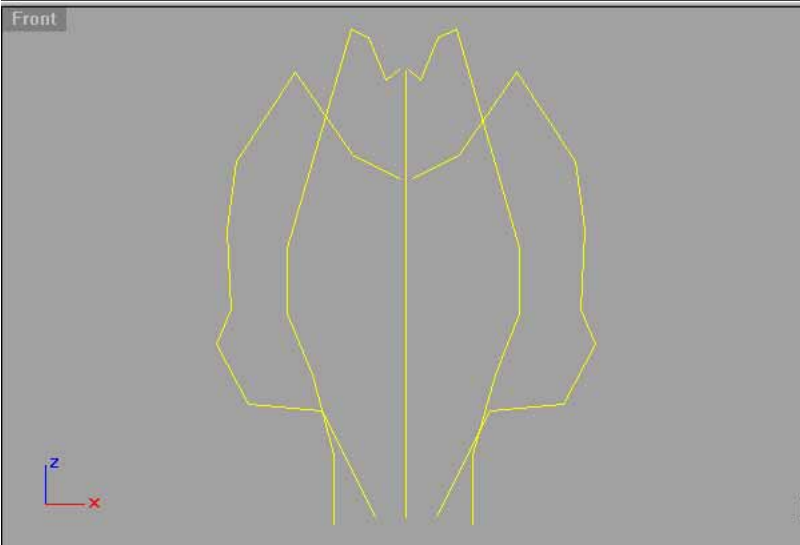
Top



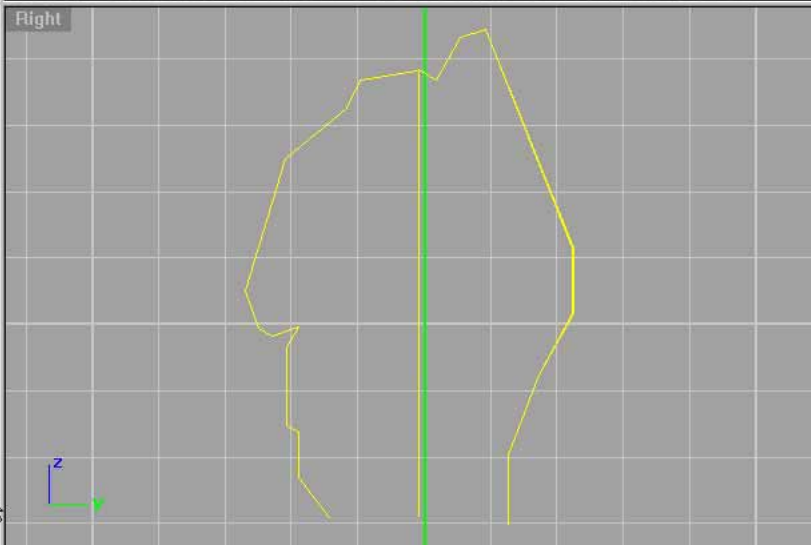
Perspective

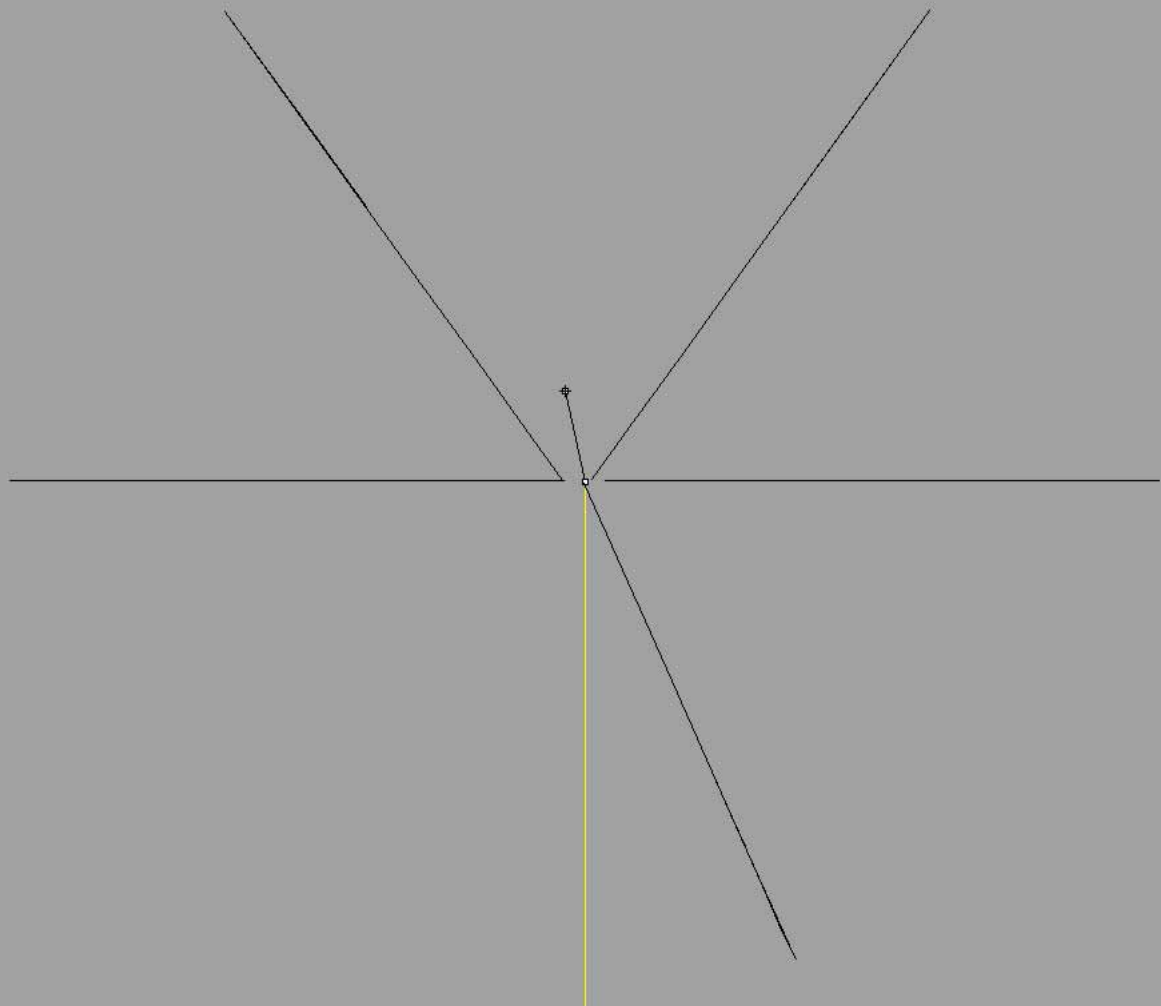


Front

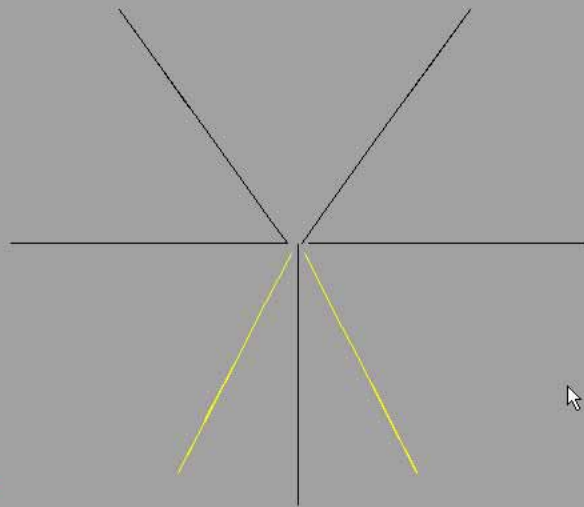


Right

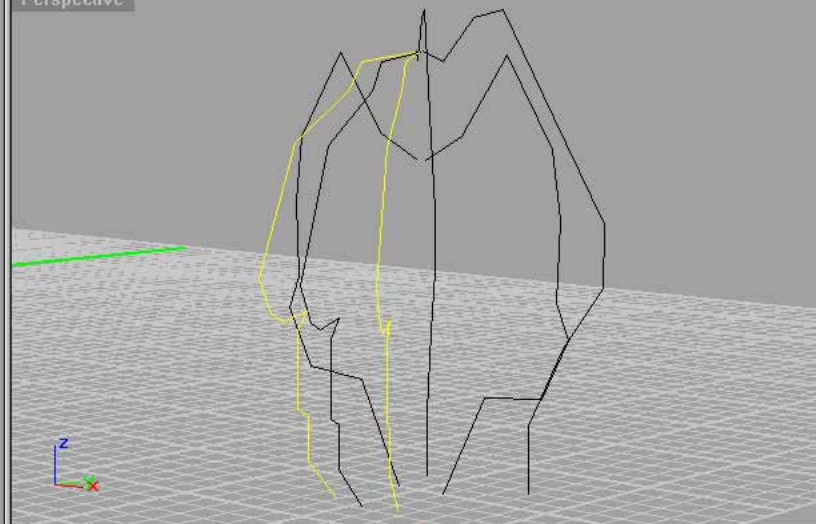




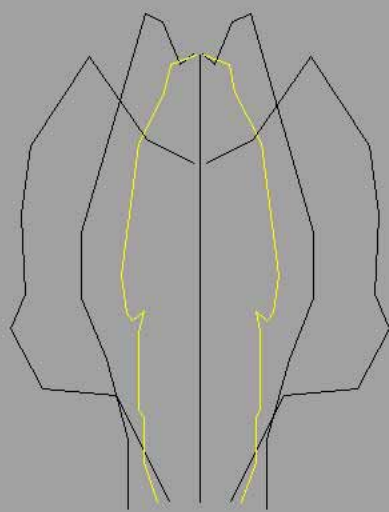
Top



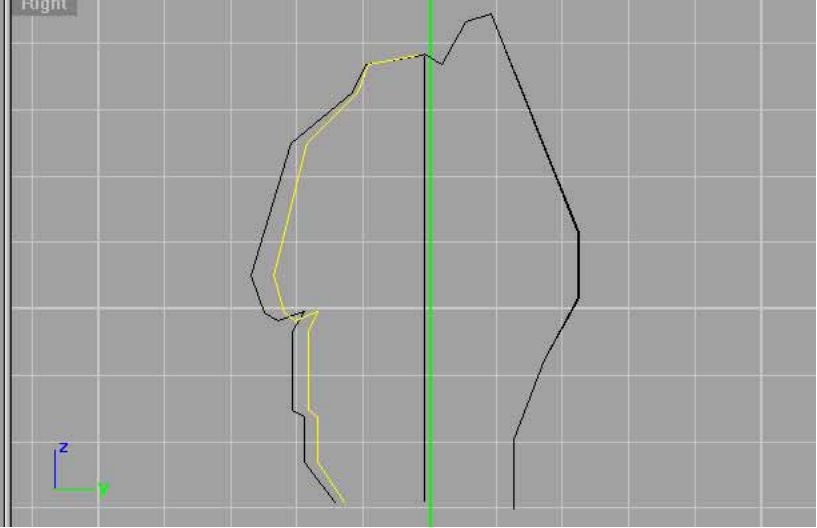
Perspective



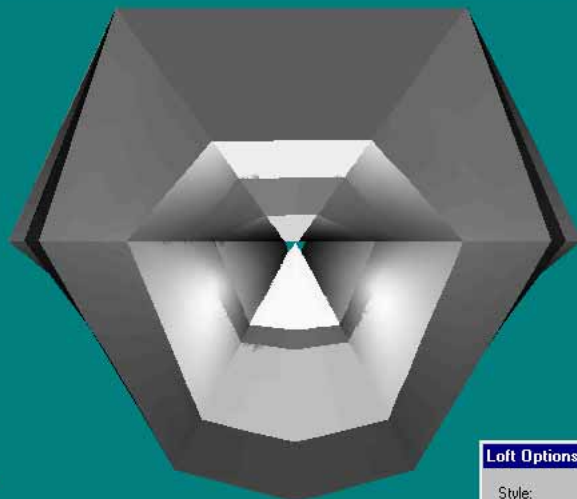
Front



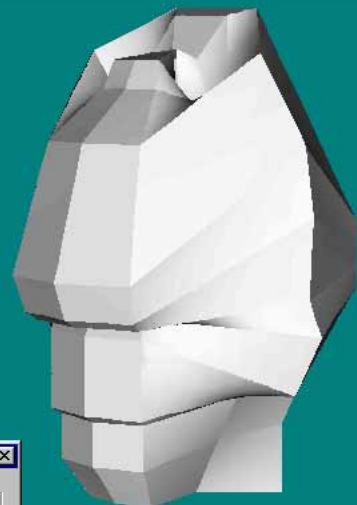
Right



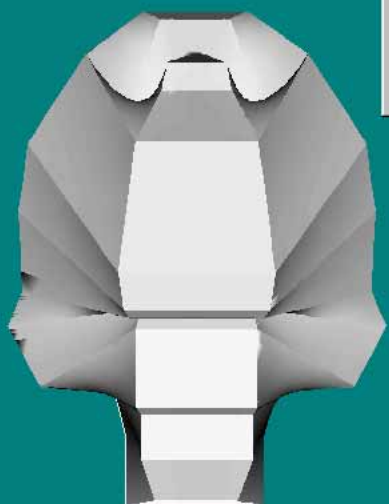
Top



Perspective



Front



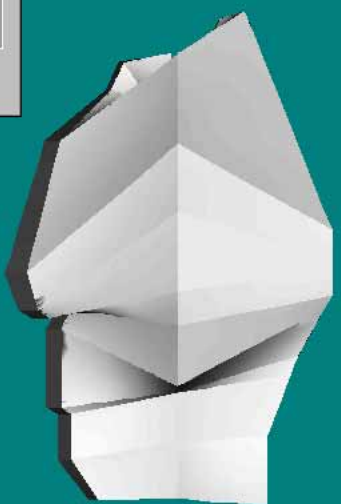
Loft Options

Style:
Straight sections

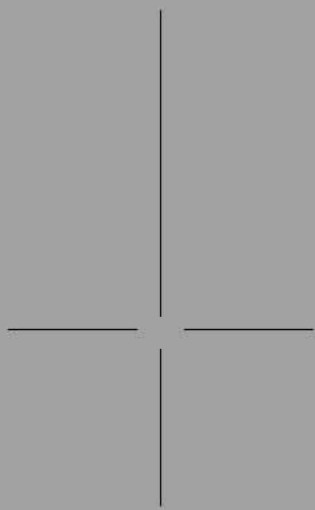
☒ Closed loft
☒ Shaded preview

Simplify:
☒ Do not simplify
☐ Rebuild with 10 control points
☐ Refit within 0.01 units

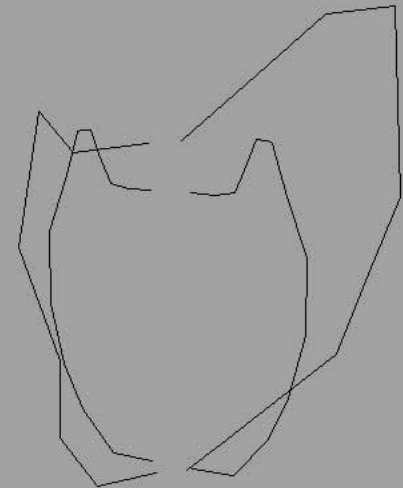
OK Cancel Preview Help



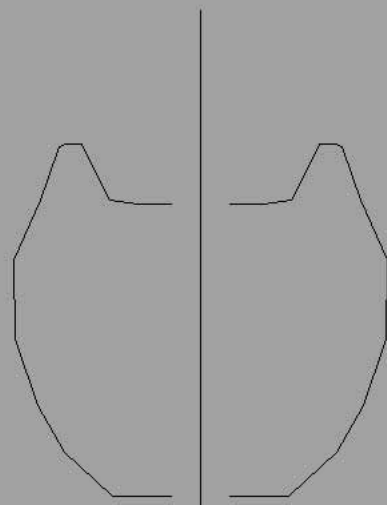
Top



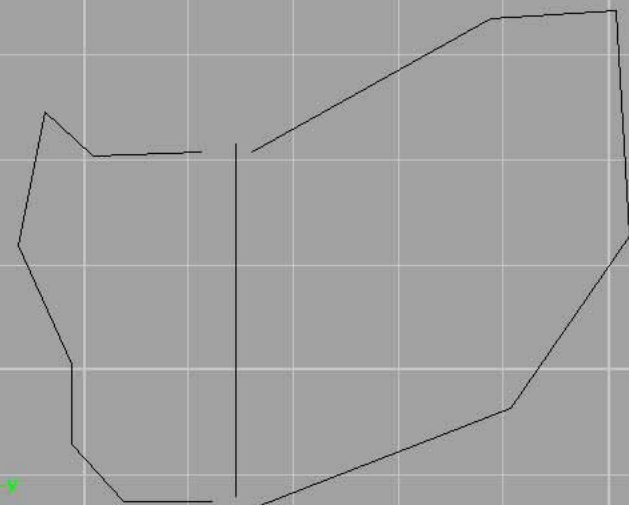
Perspective



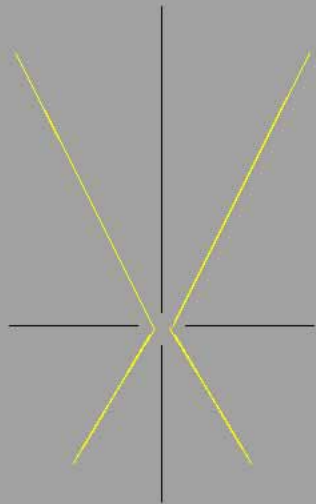
Front



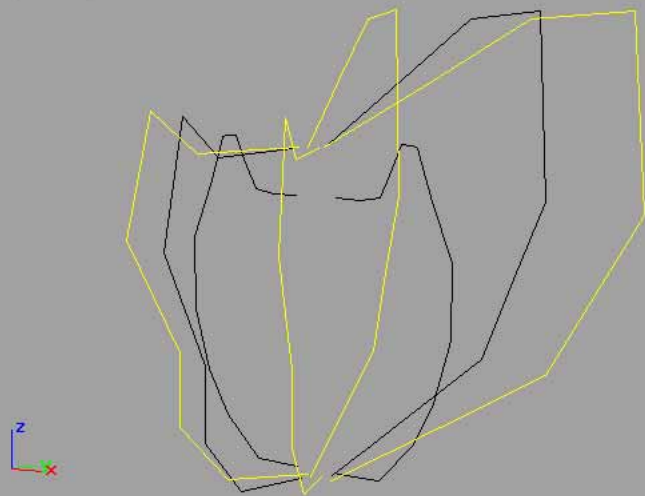
Right



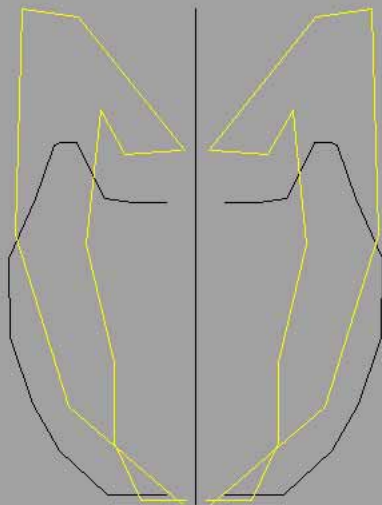
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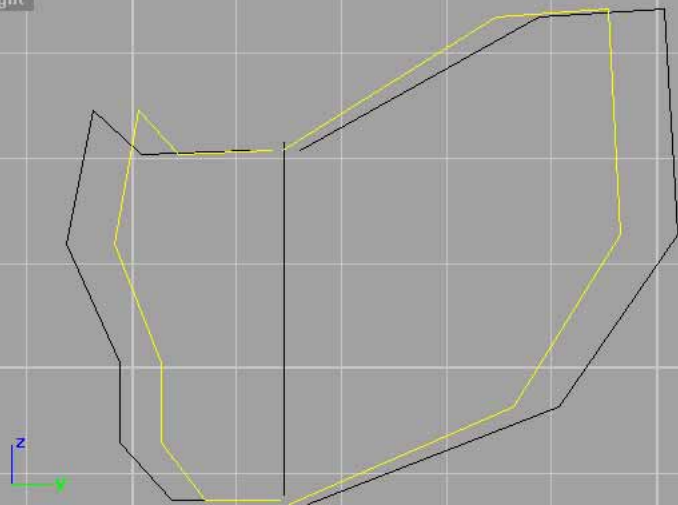
Perspective



Front



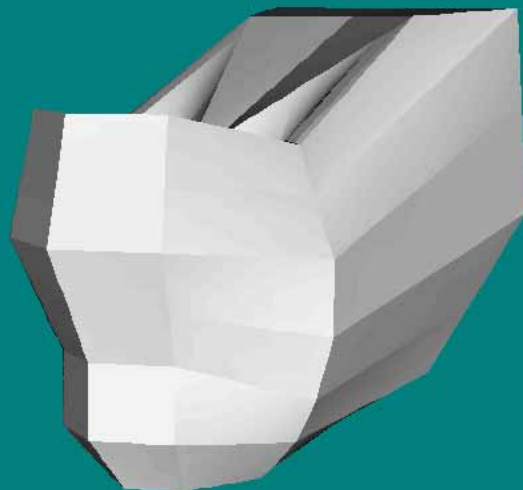
Right



Top



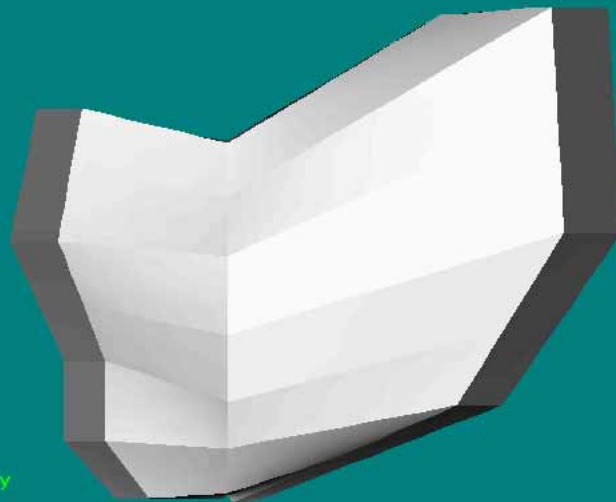
Perspective



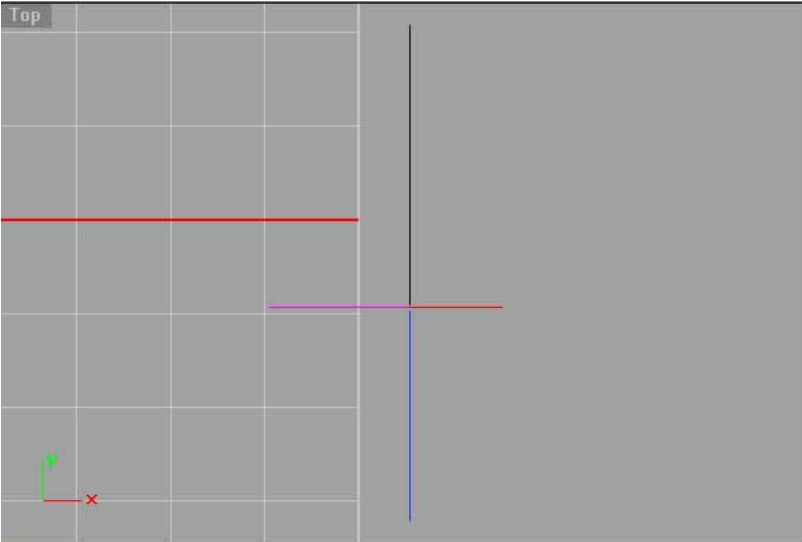
Front



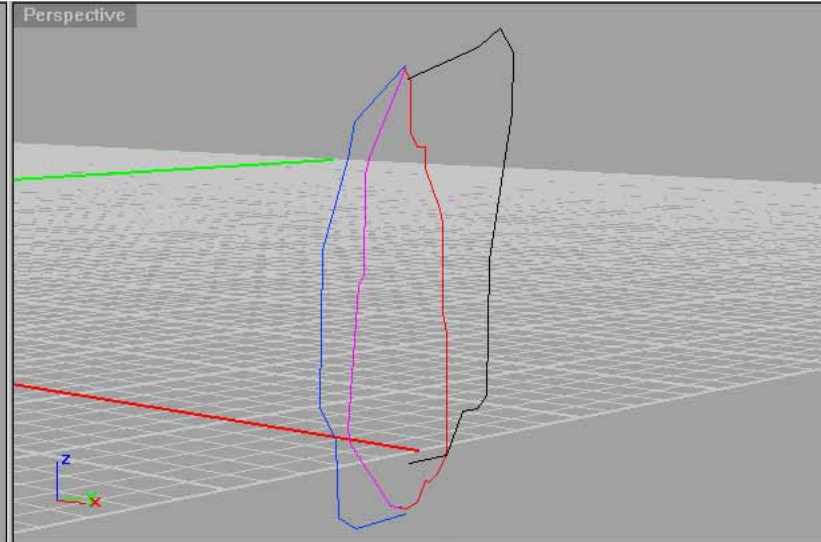
Right



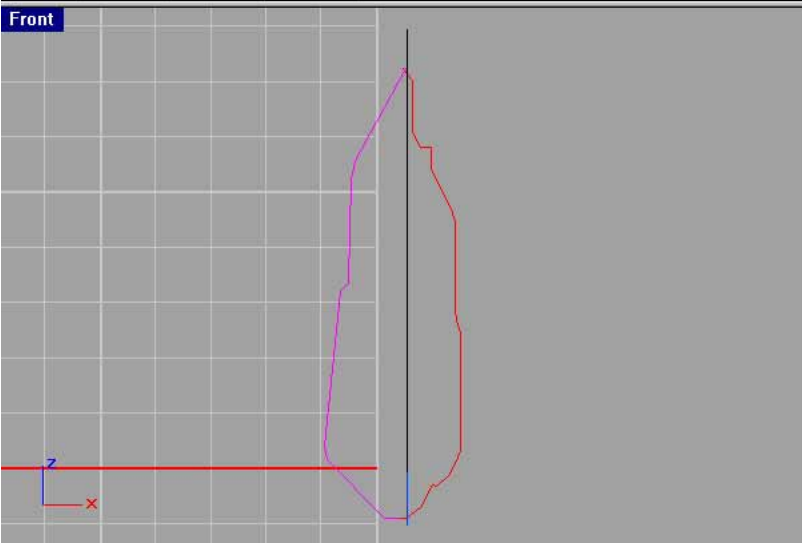
Top



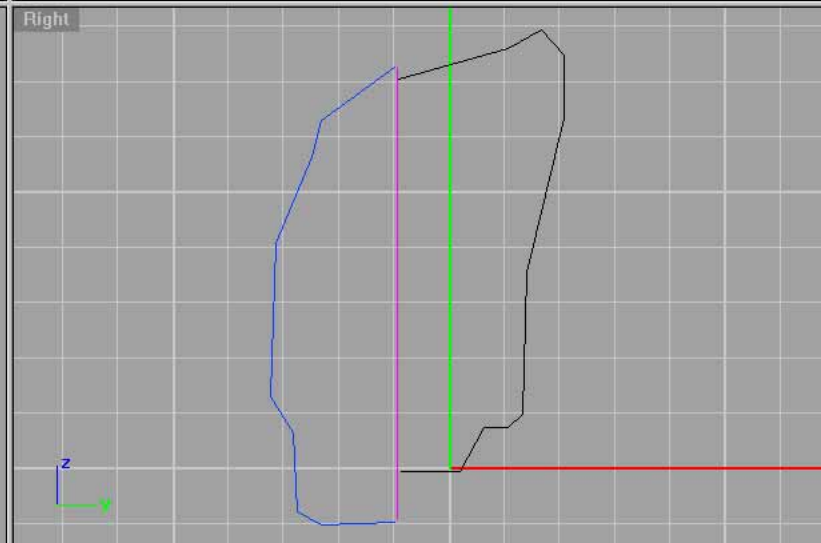
Perspective



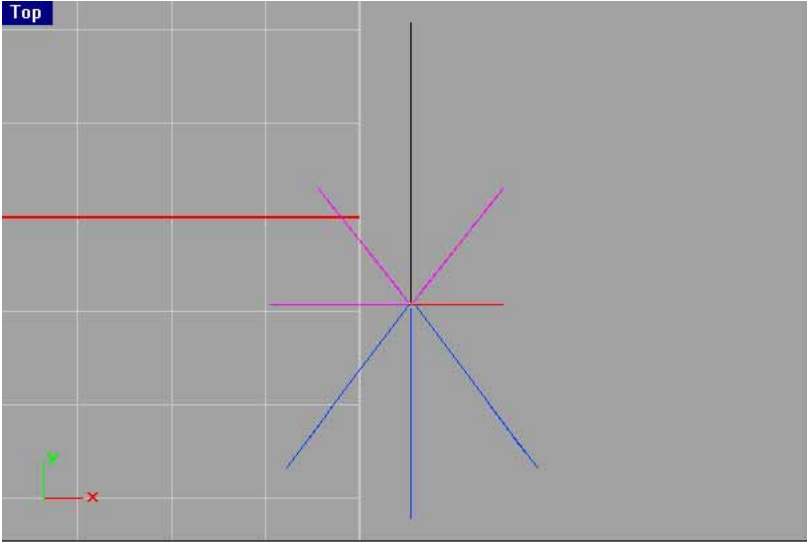
Front



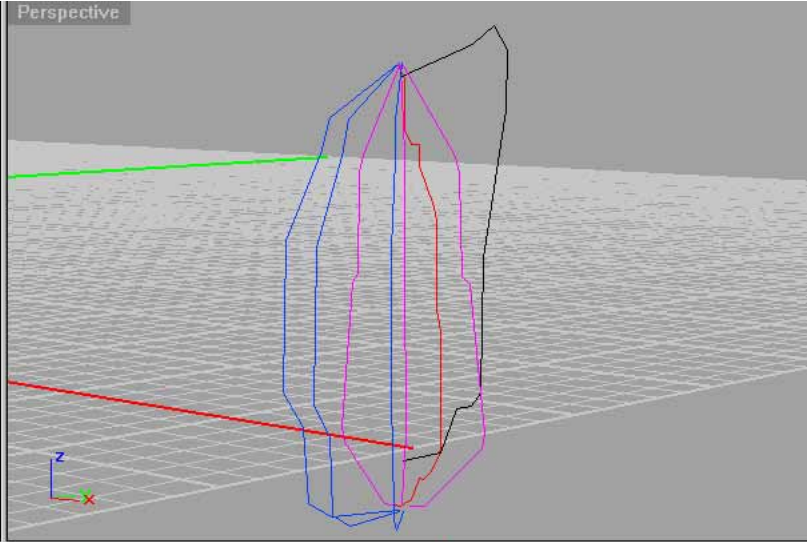
Right



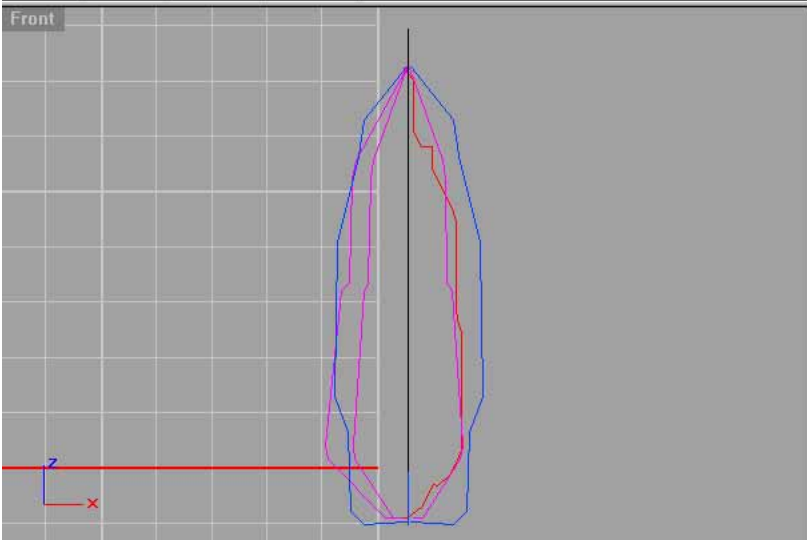
Top



Perspective



Front



Right



Top



Perspective



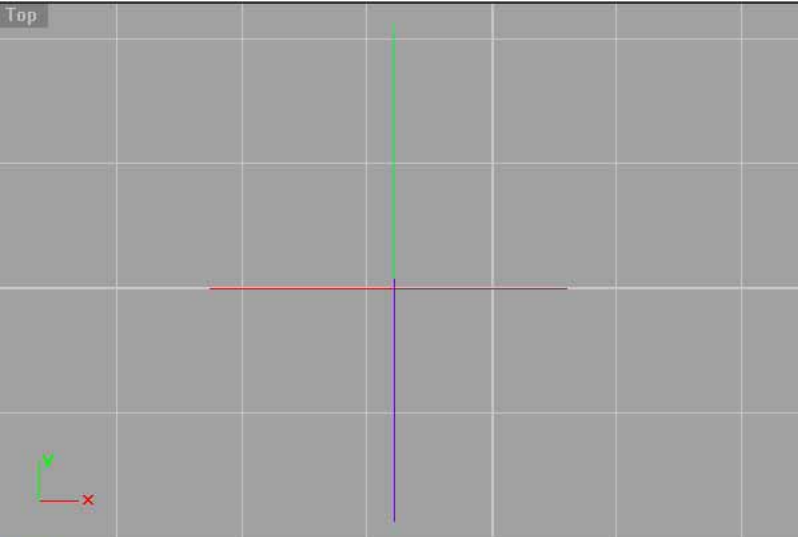
Front



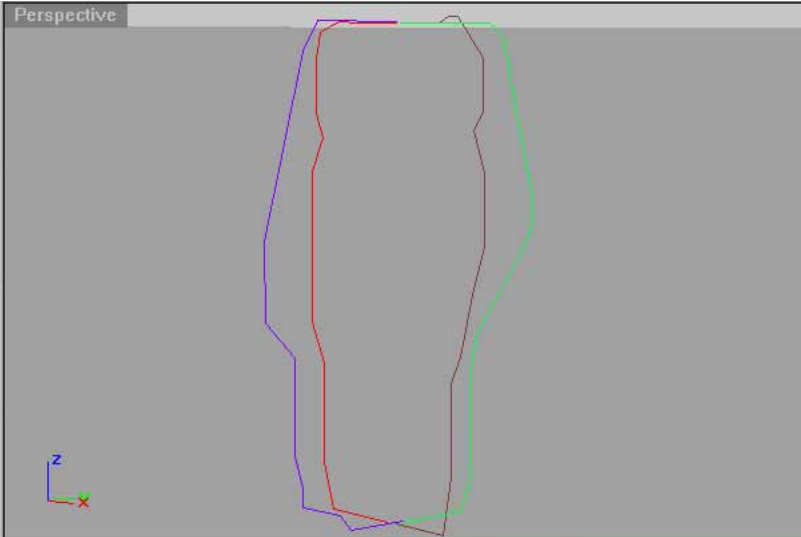
Right



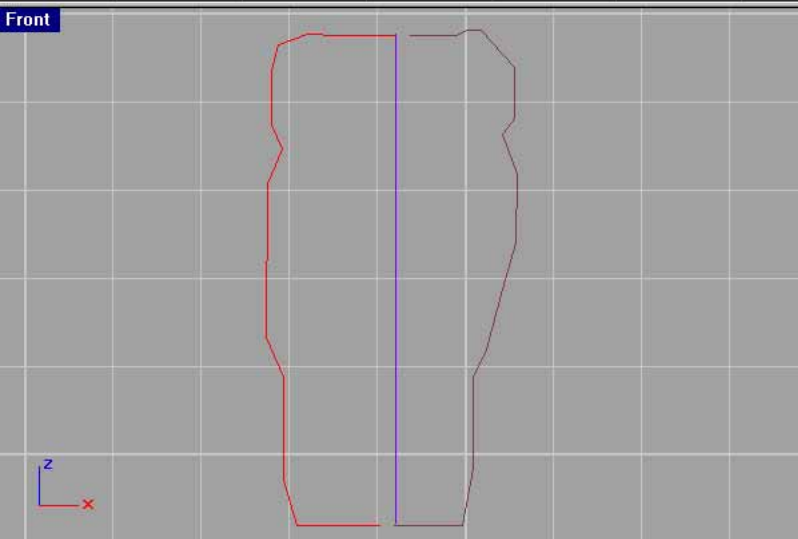
Top



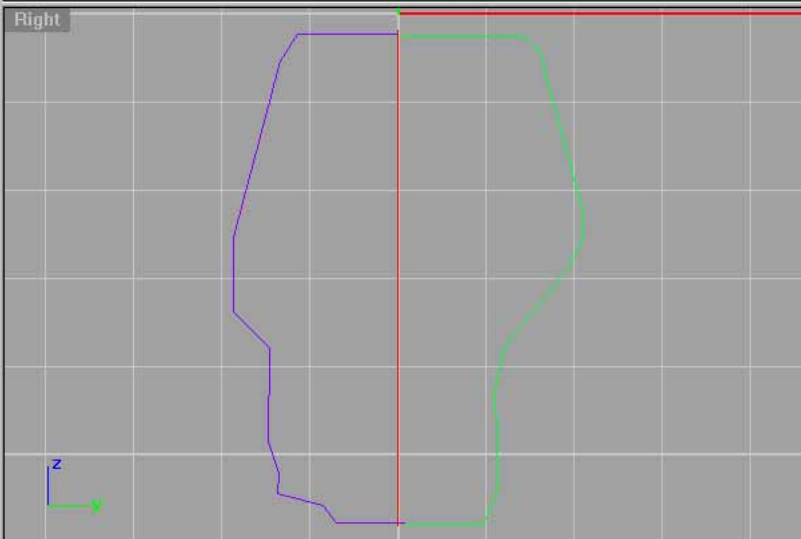
Perspective



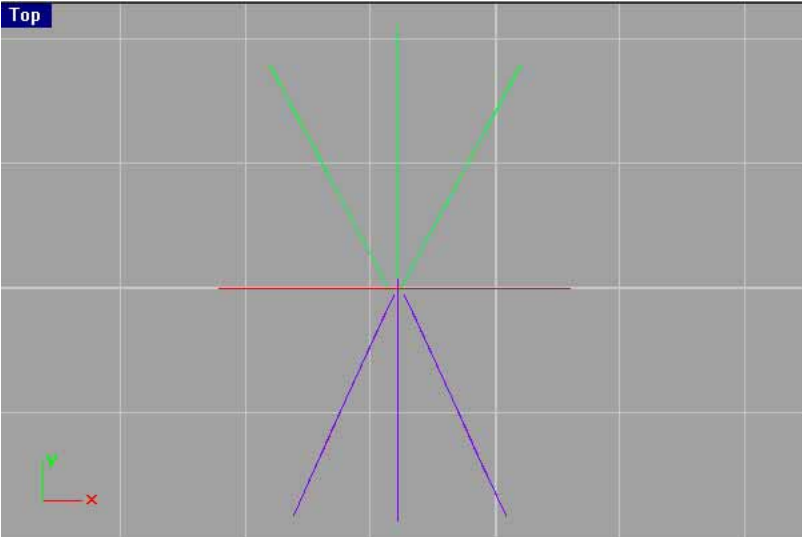
Front



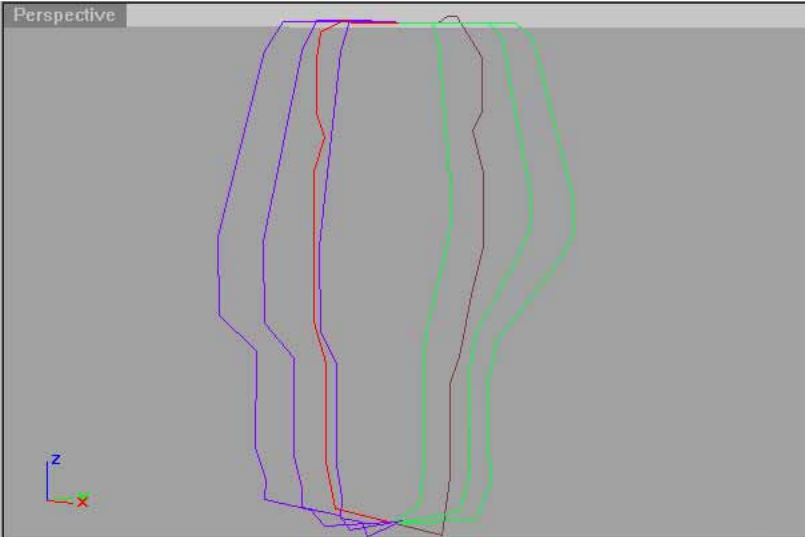
Right



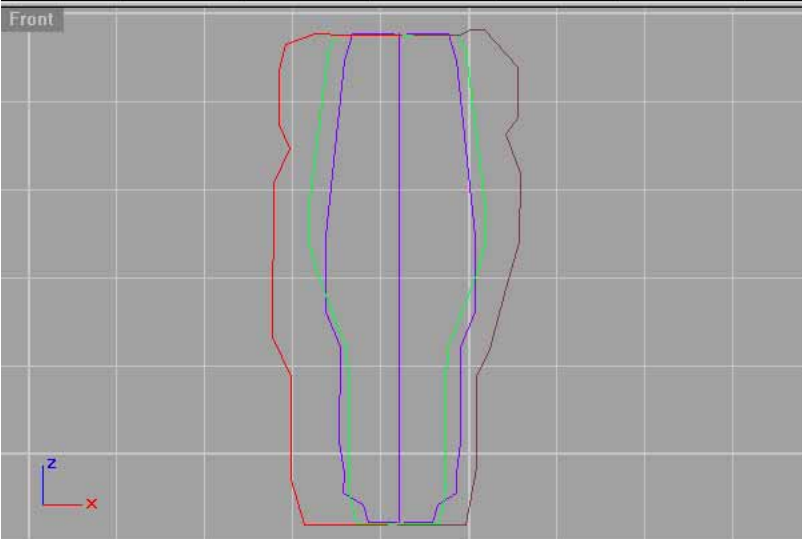
Top



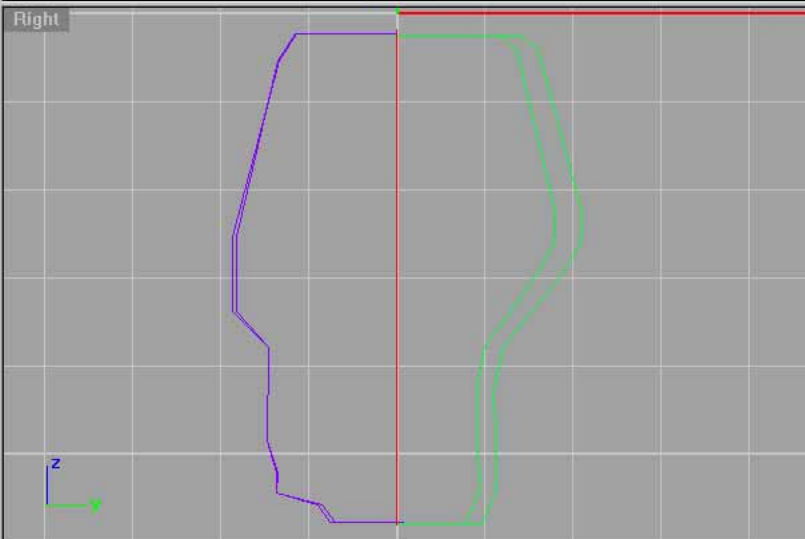
Perspective



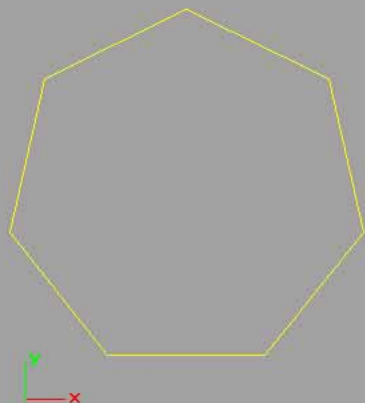
Front



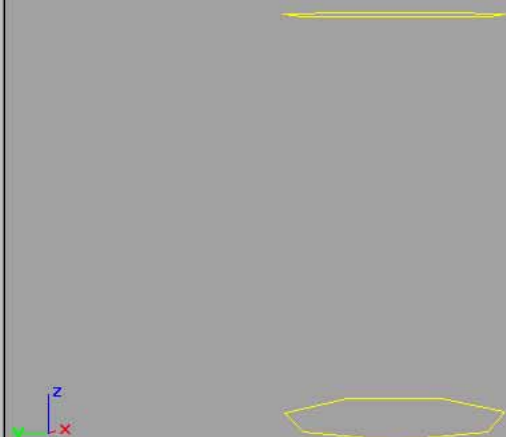
Right



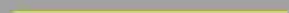
Top



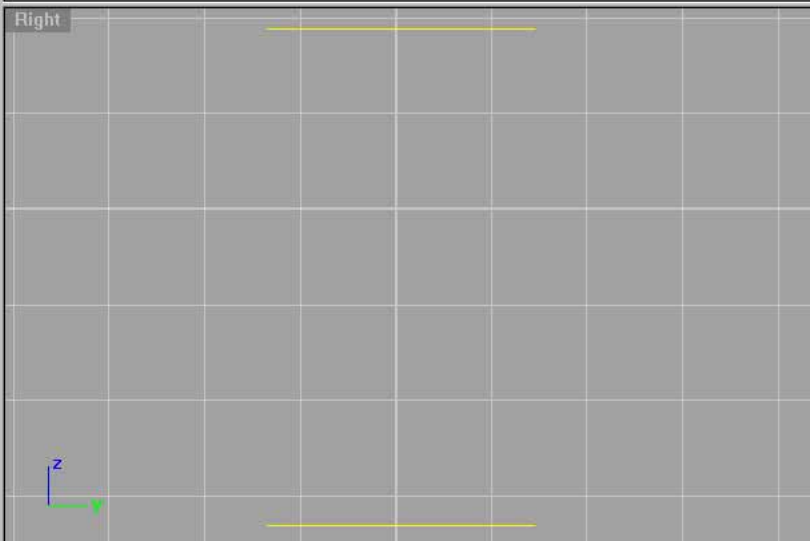
Perspective



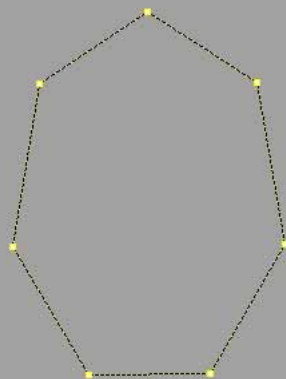
Front



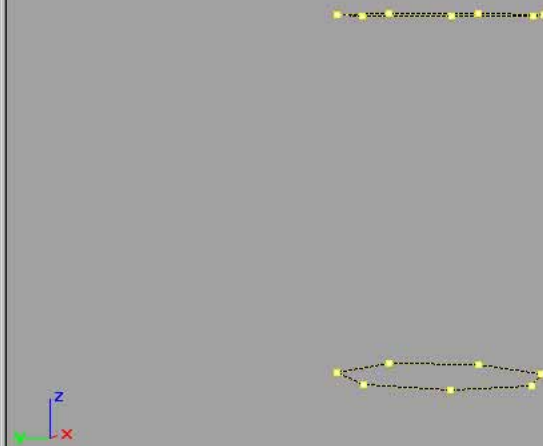
Right



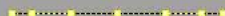
Top



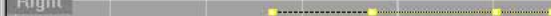
Perspective



Front



Right



Top

Perspective



z

Front



Loft Options [X]

Style:
Straight sections ▾

☐ Closed loft

☒ Shaded preview

Simplify:
☒ Do not simplify

☐ Rebuild with control points

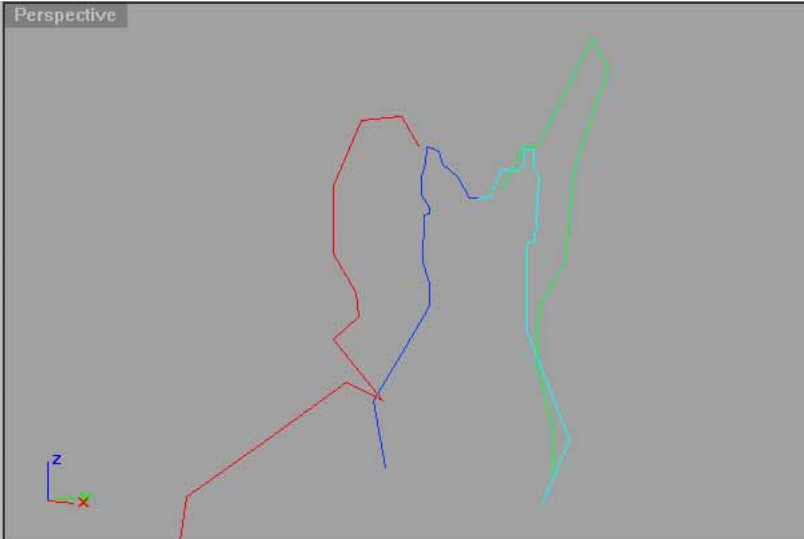
☐ Refit within units

OK Cancel Preview Help

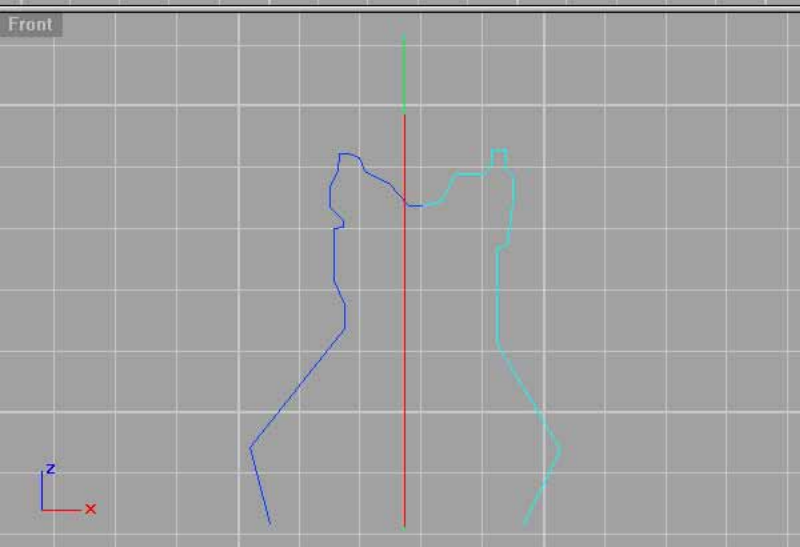
Top



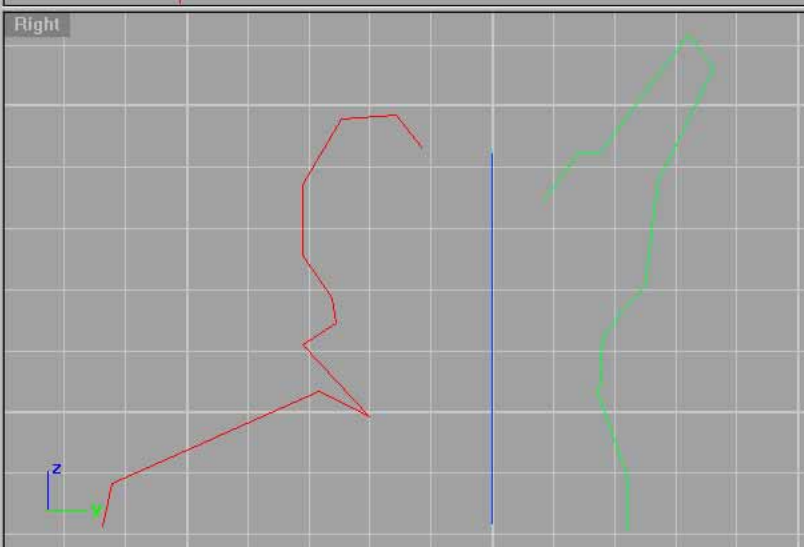
Perspective



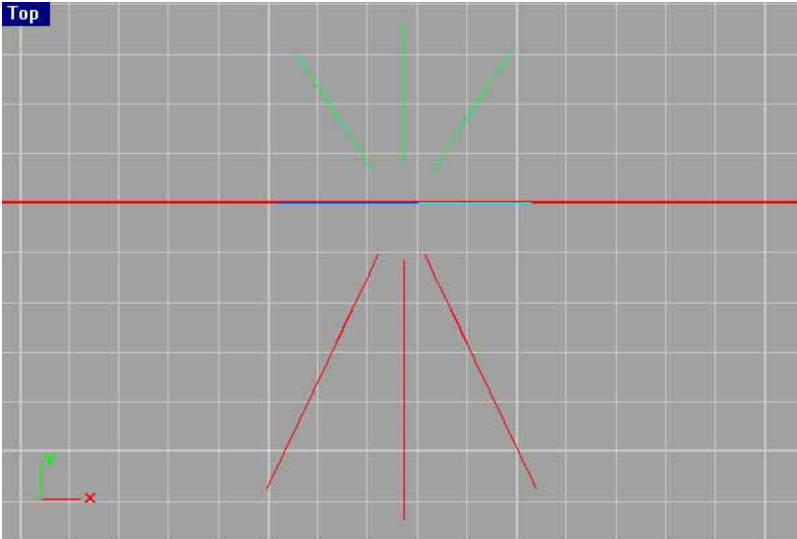
Front



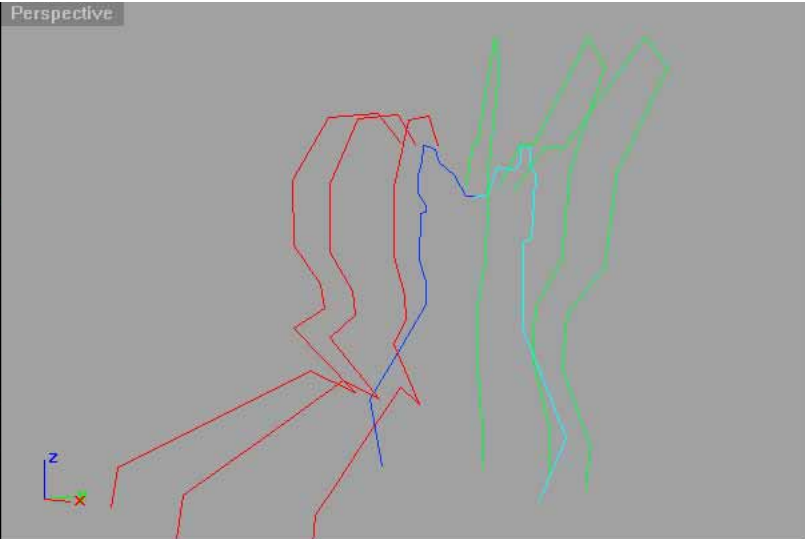
Right



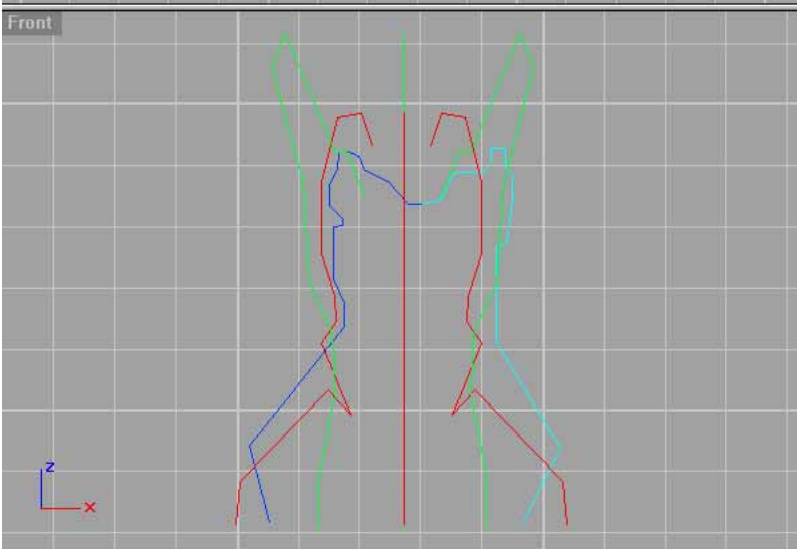
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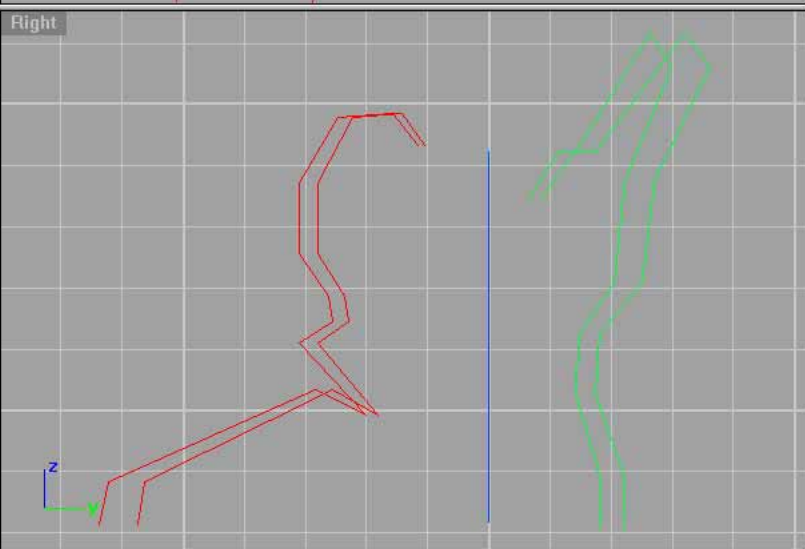
Perspective



Front

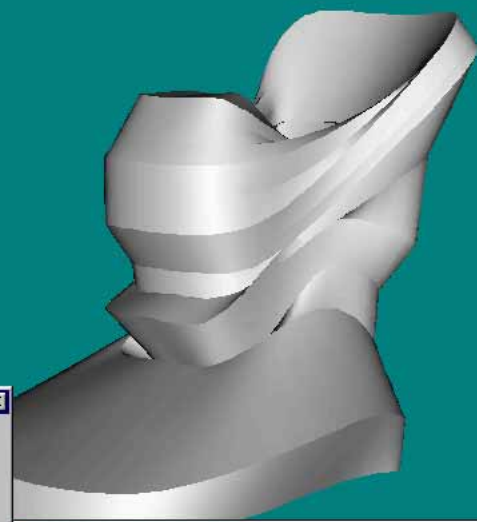
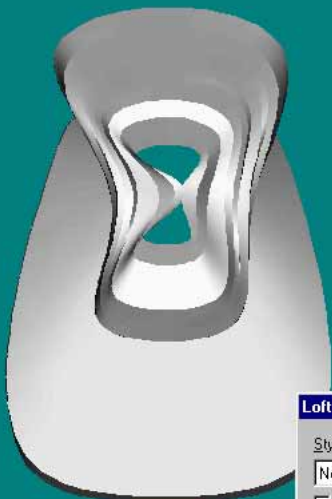


Right

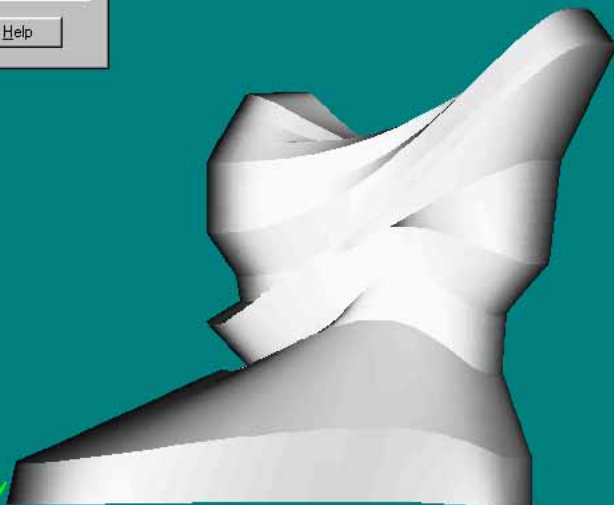
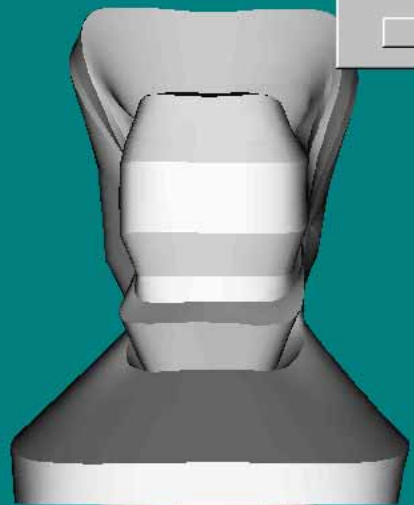


Top

Perspective



Front



Loft Options [X]

Style: [Normal v]

☒ Closed loft

☒ Shaded preview

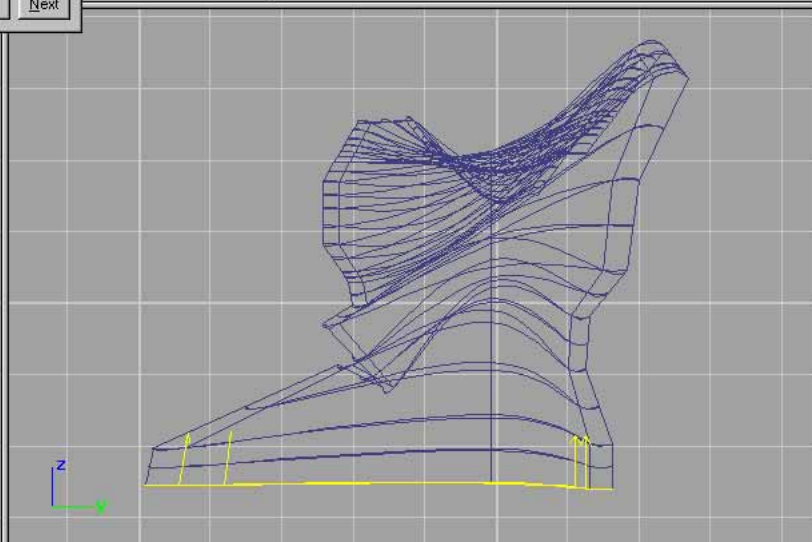
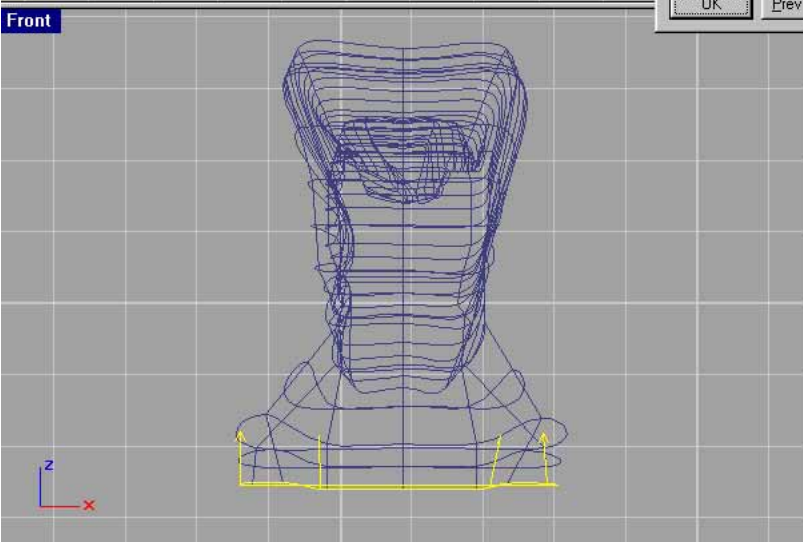
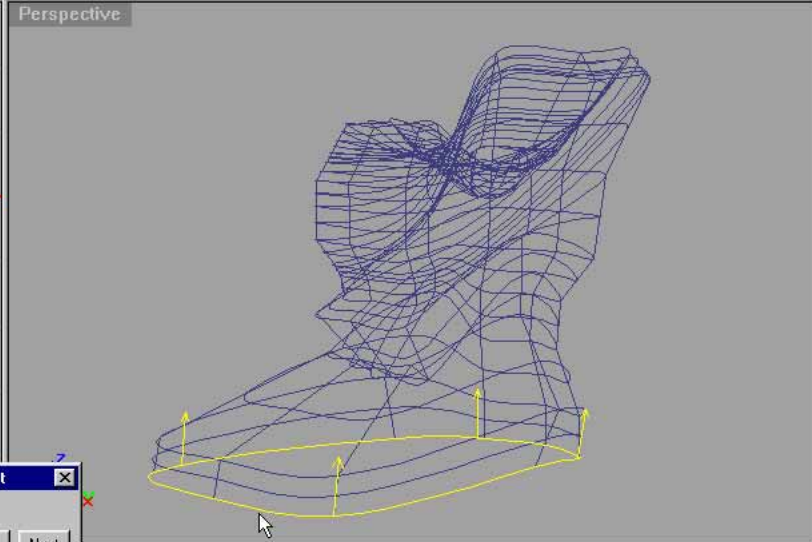
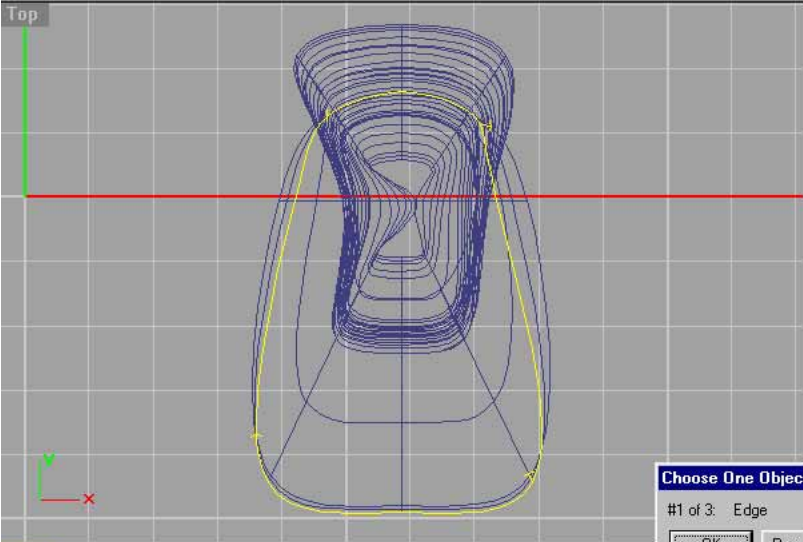
Simplify:

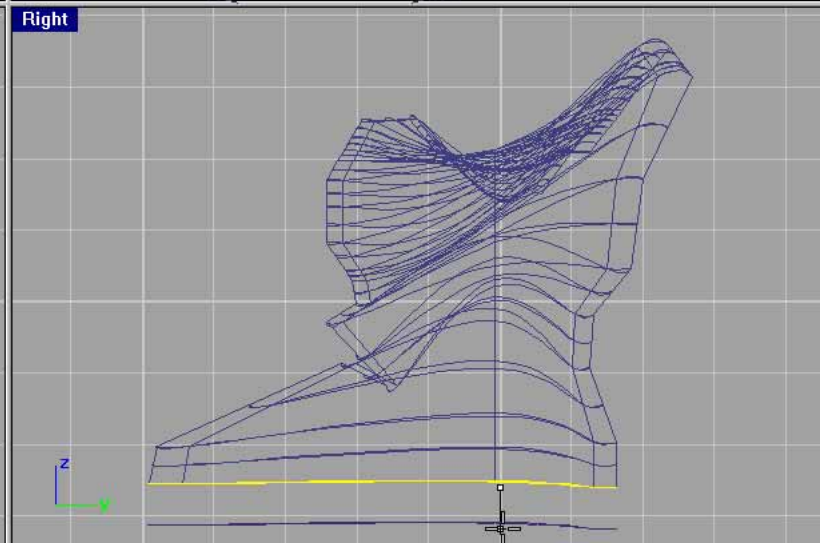
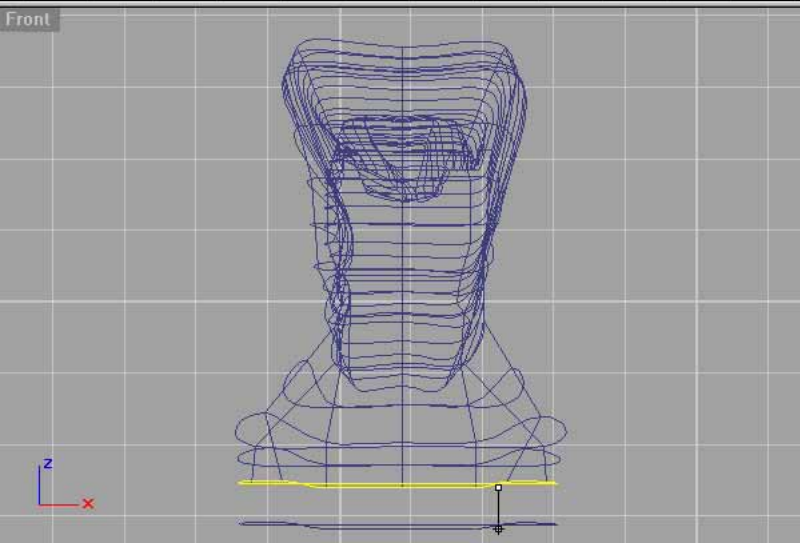
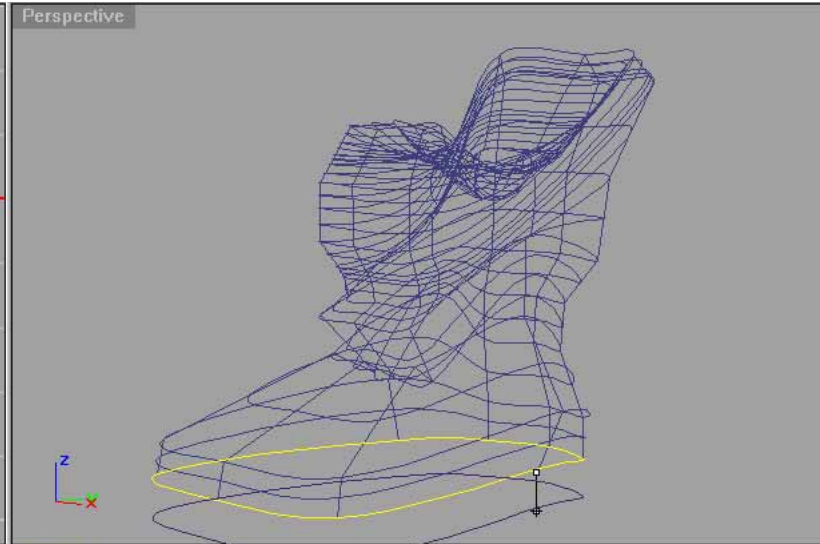
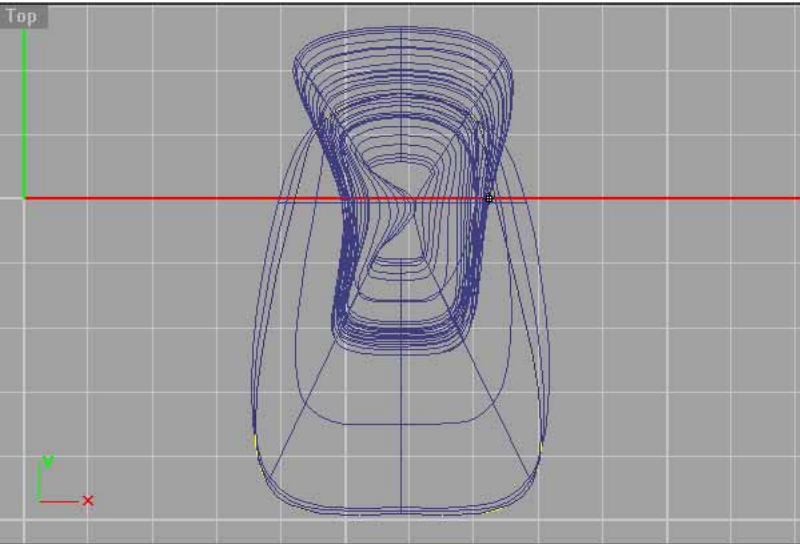
☒ Do not simplify

☐ Rebuild with [10] control points

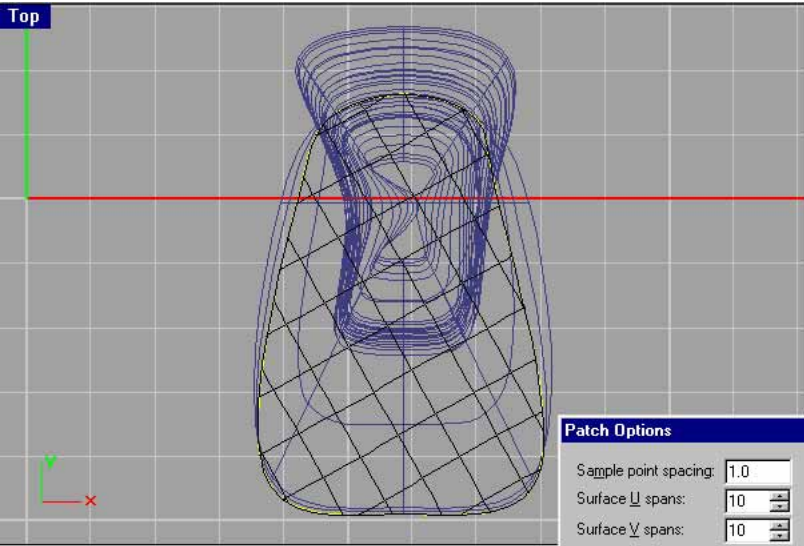
☐ Refit within [0.01] units

[OK] [Cancel] [Preview] [Help]

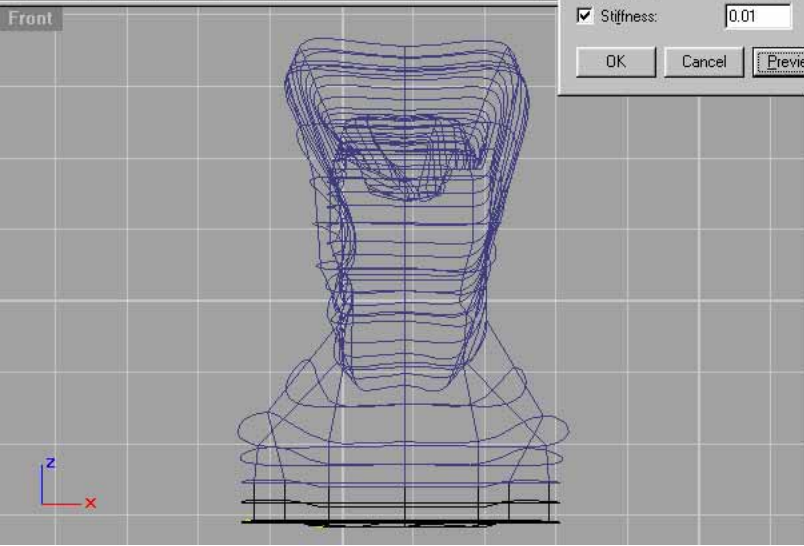




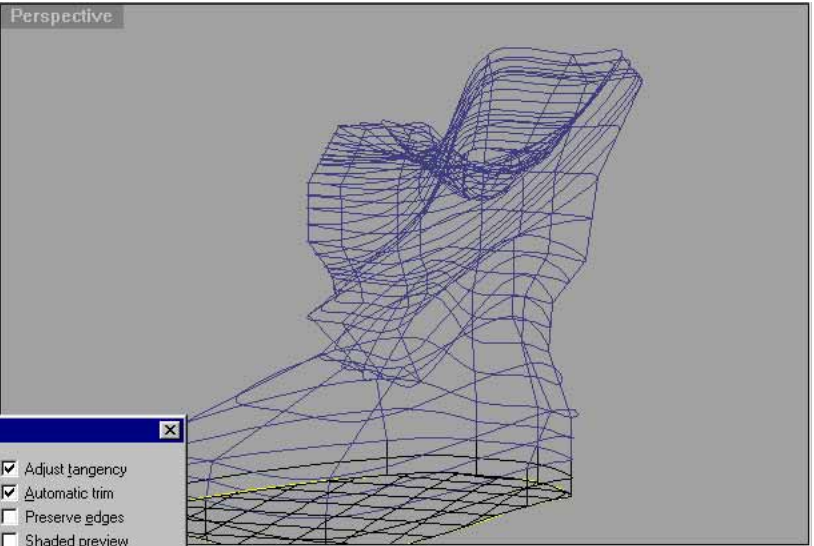
Top



Front



Perspective



Patch Options

Sample point spacing: 1.0
Surface U spans: 10
Surface V spans: 10
☒ Stiffness: 0.01

☒ Adjust tangency
☒ Automatic trim
☐ Preserve edges
☐ Shaded preview

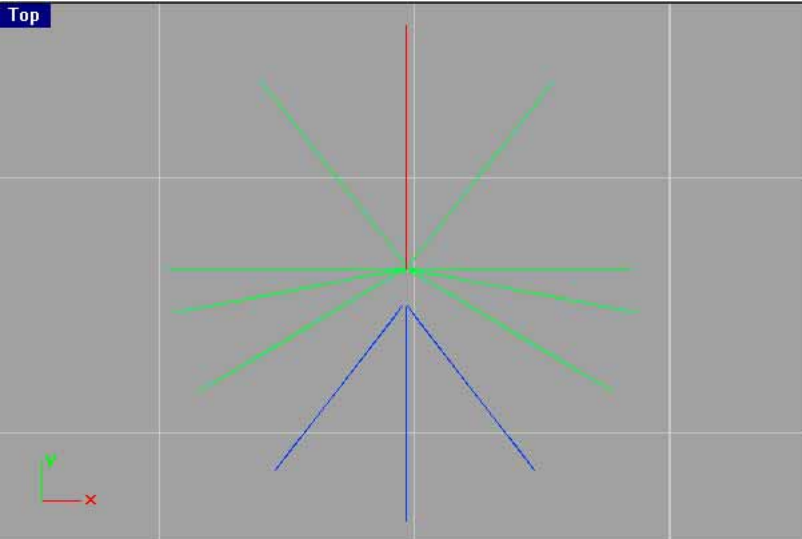
OK

Cancel

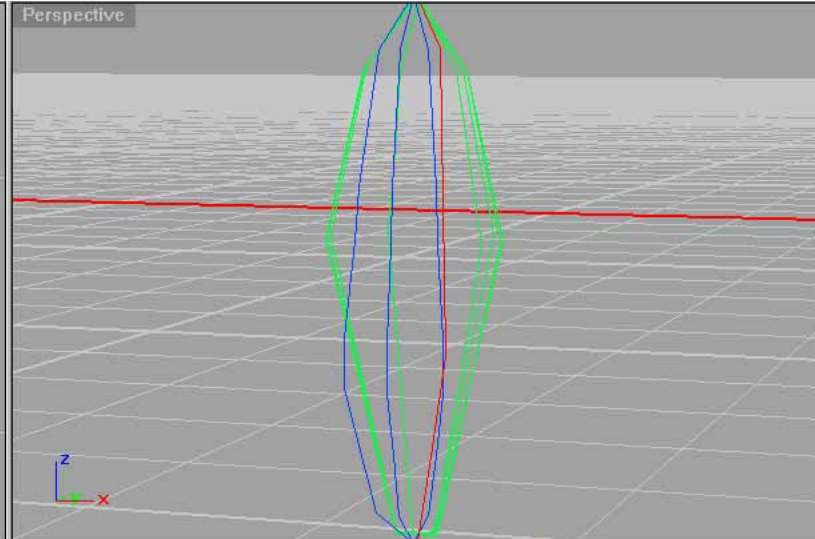
Preview

Starting Surface...

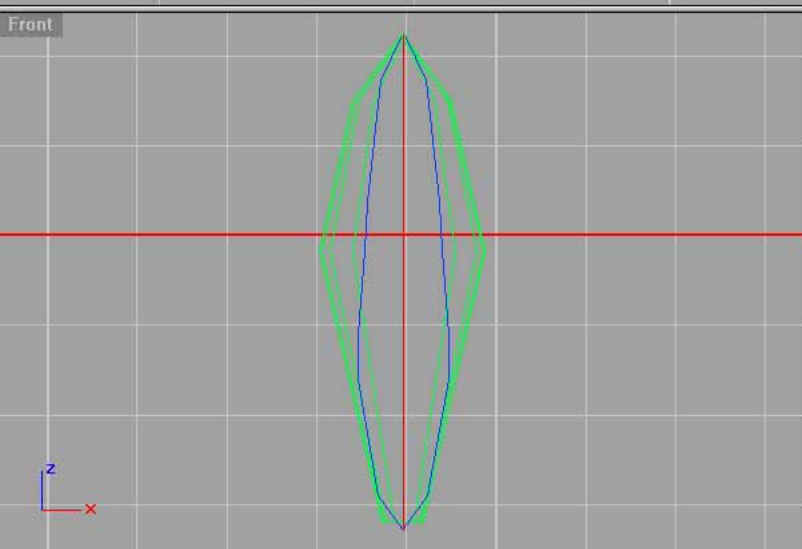
Top



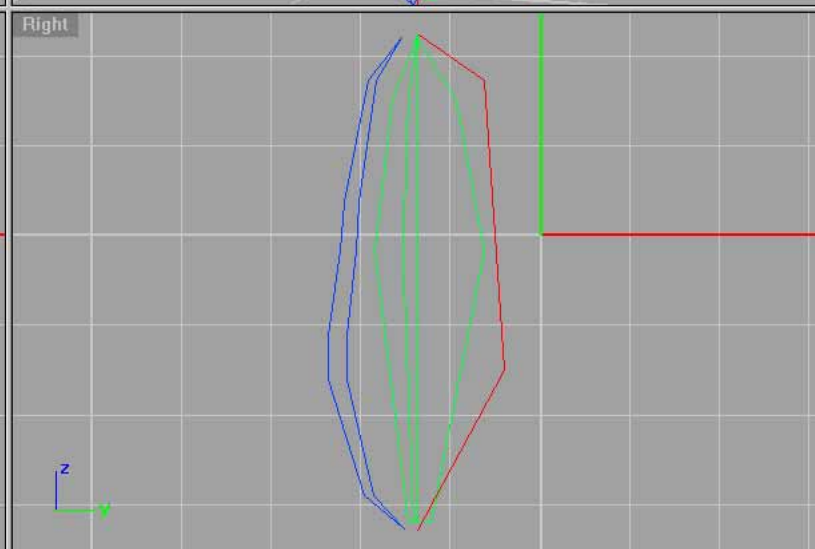
Perspective



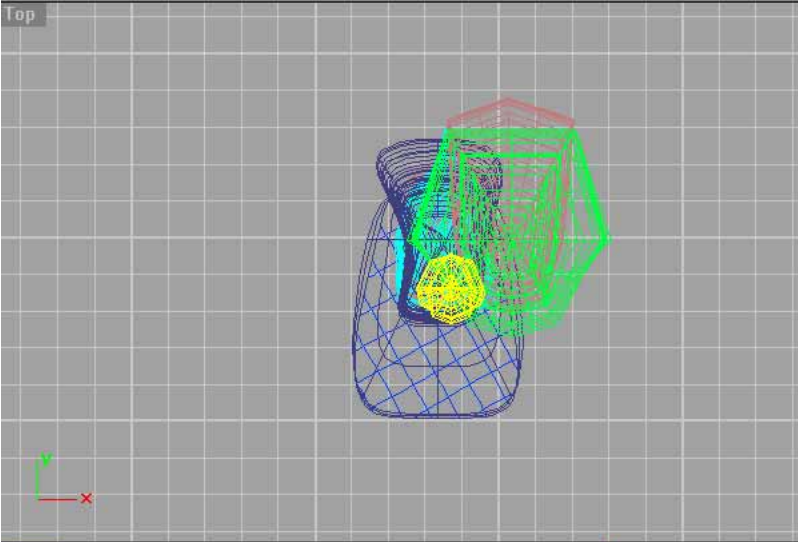
Front



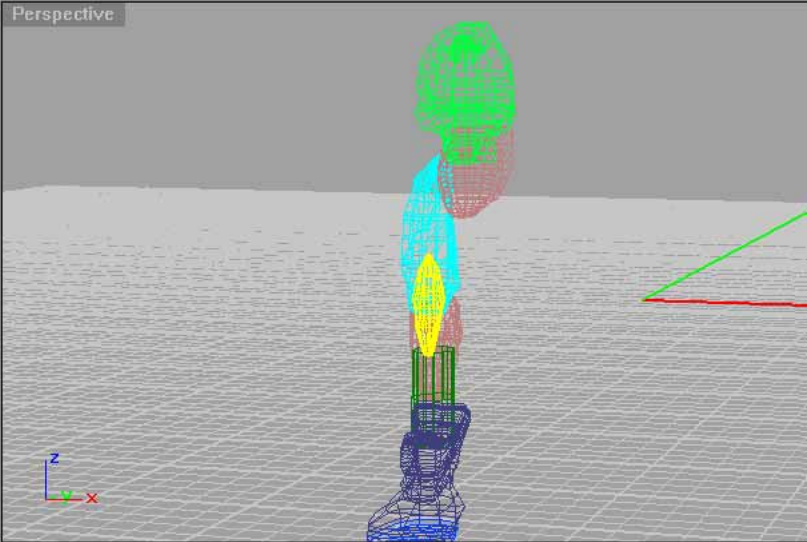
Right



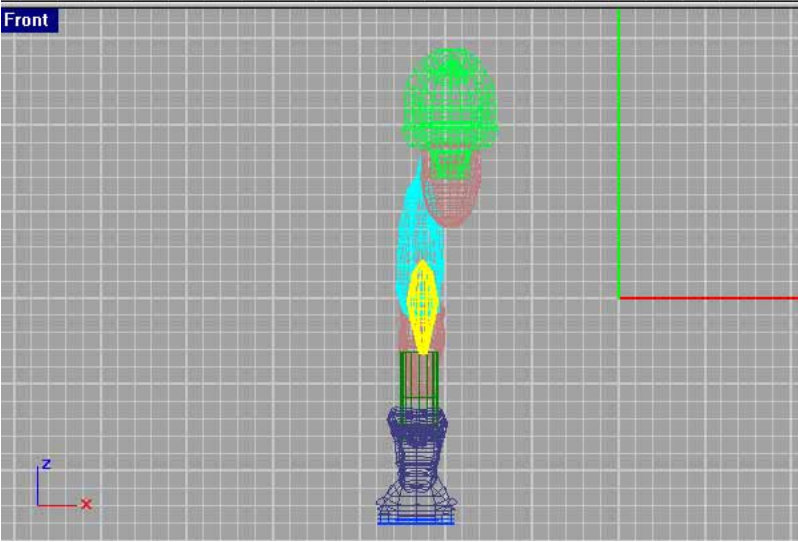
Top



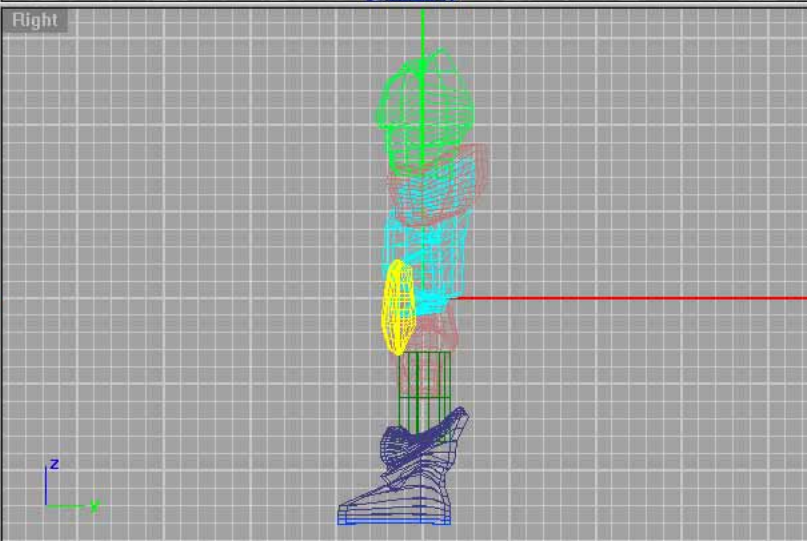
Perspective

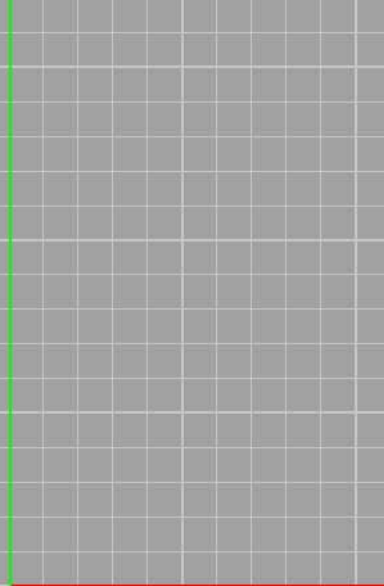
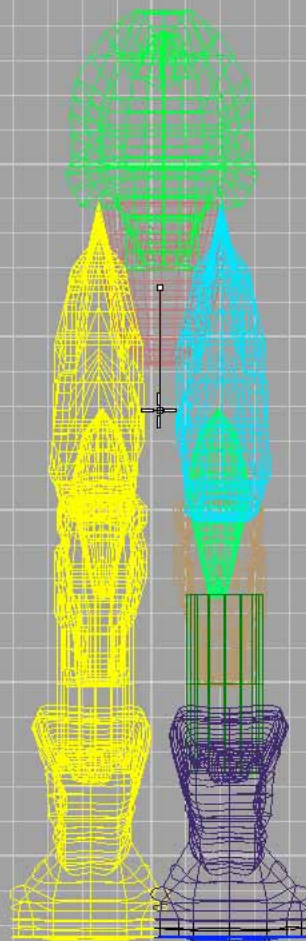


Front

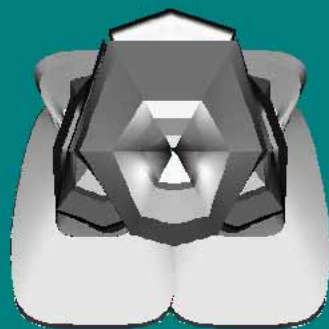


Right

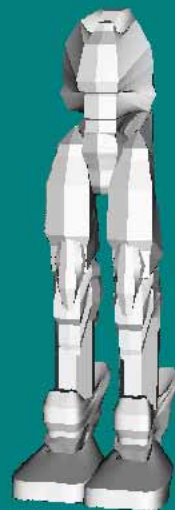




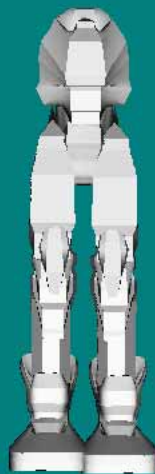
Top



Perspective



Front



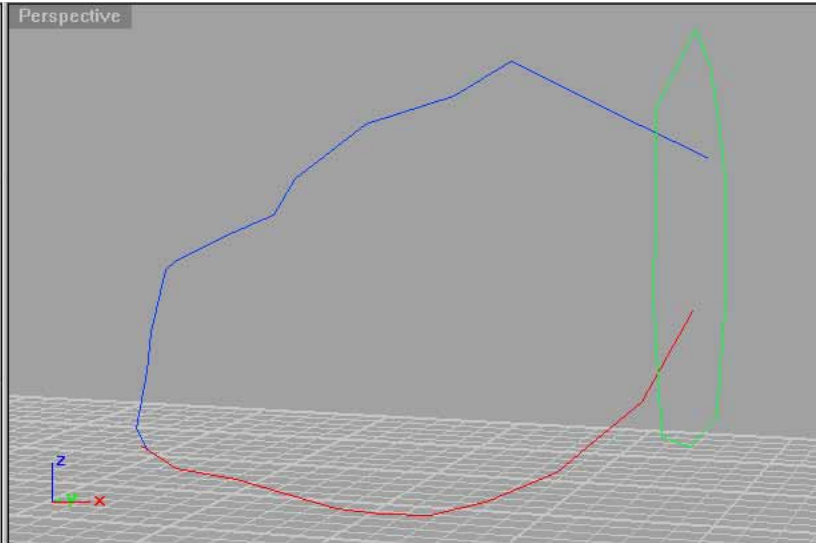
Right



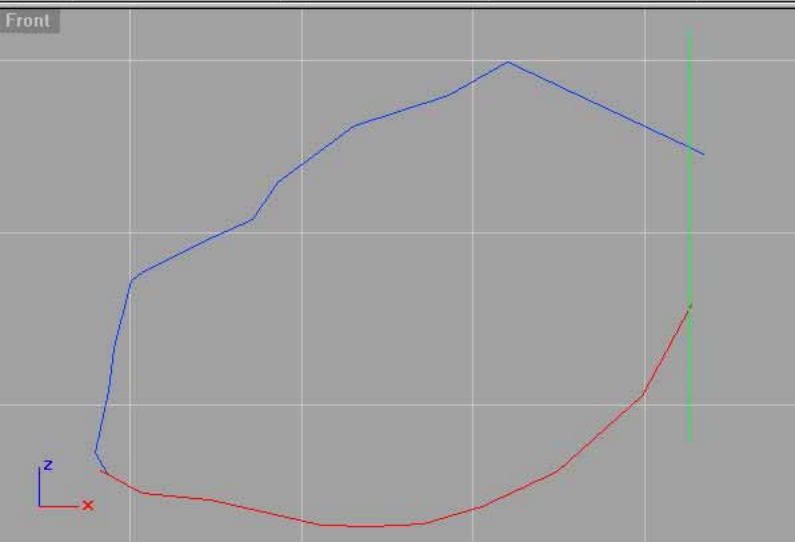
Top



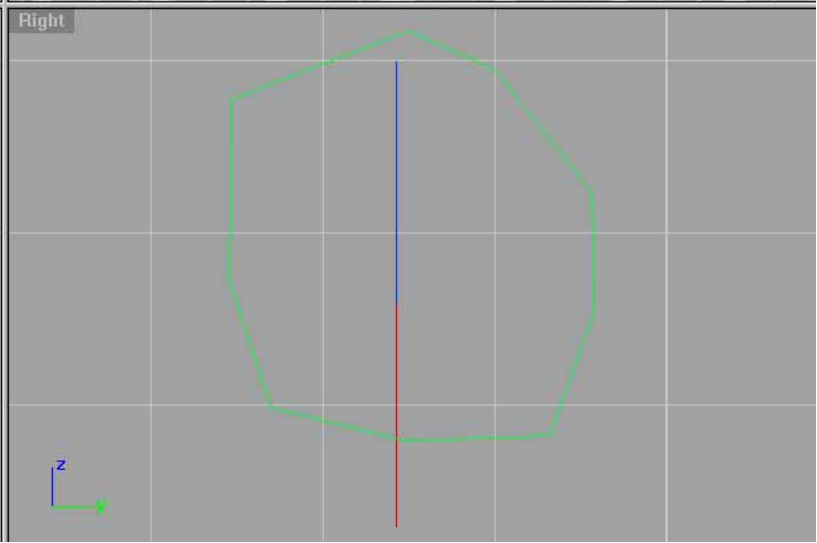
Perspective



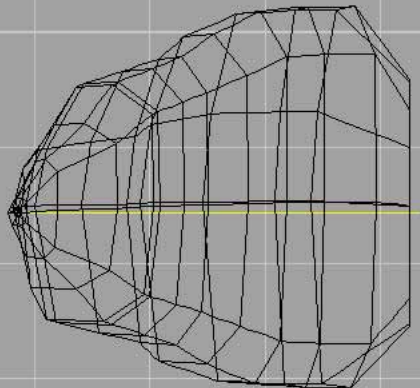
Front



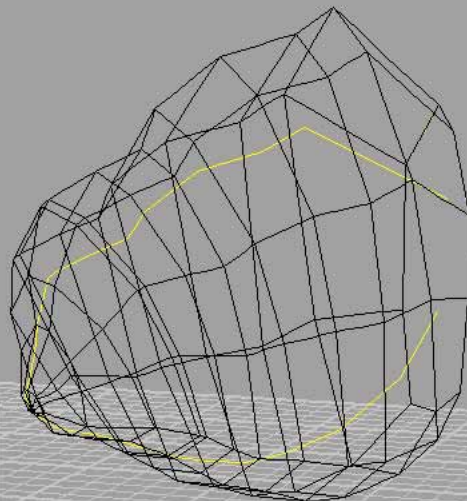
Right



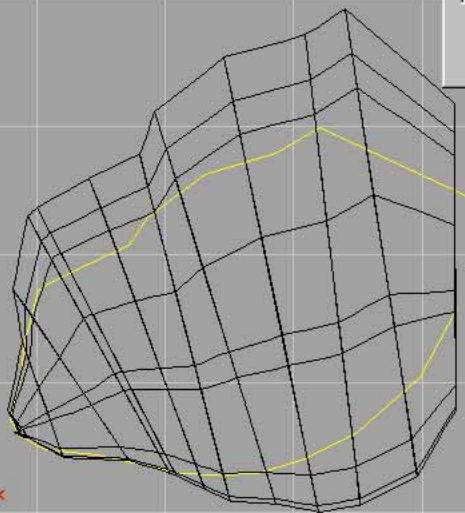
Top



Perspective



Front



Sweep 2 Rails Options

- ☐ Maintain height
☐ Closed sweep
☐ Shaded preview

Simplify

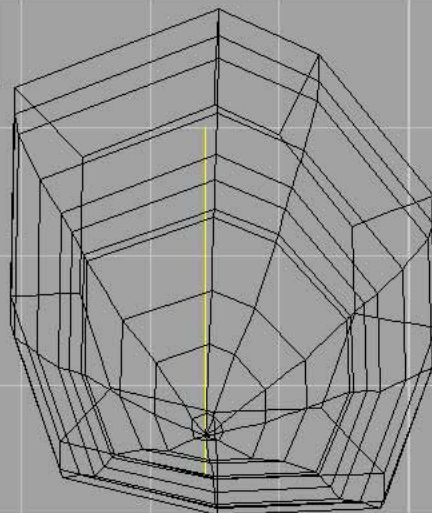
- ☒ Do not simplify
☐ Rebuild with control points
☐ Refit within units

OK

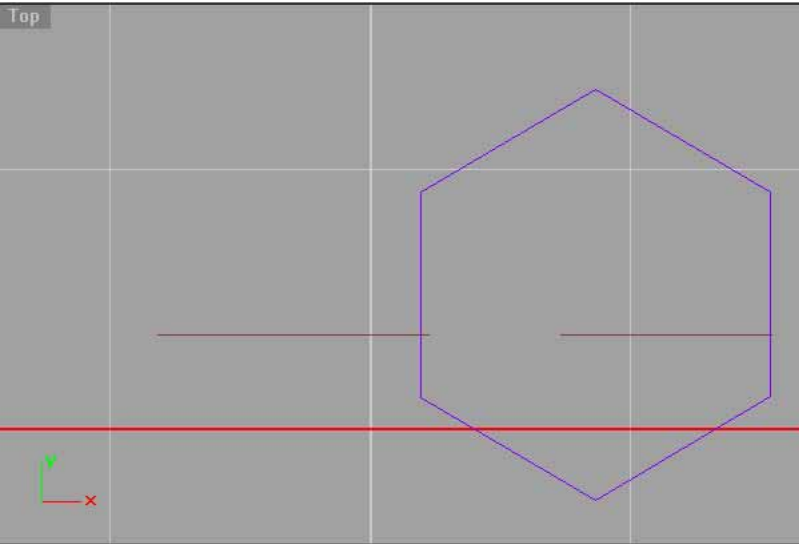
Cancel

Preview

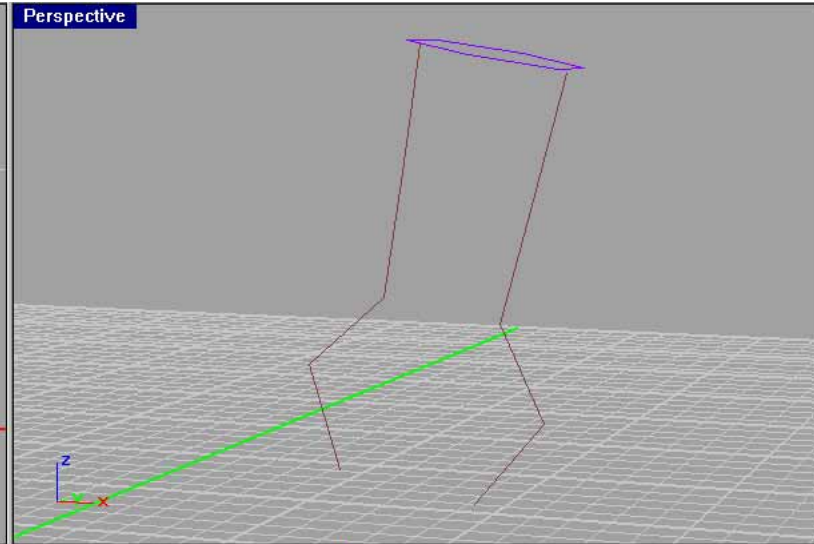
Help



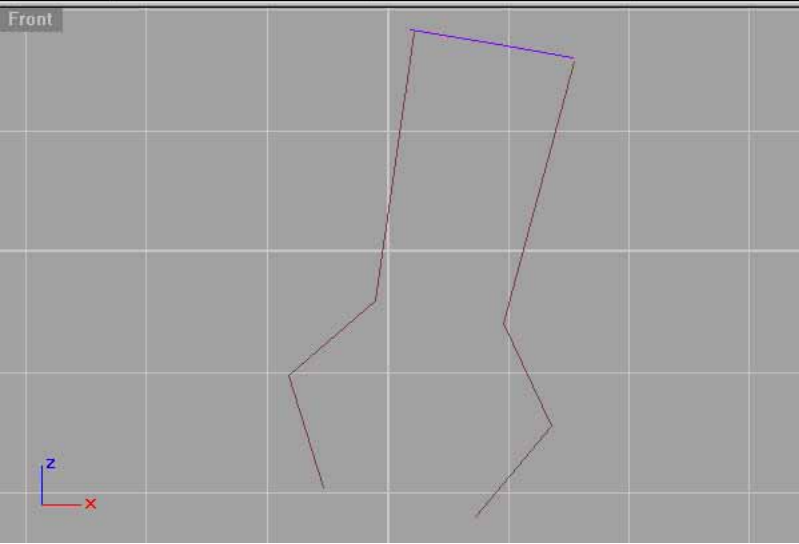
Top



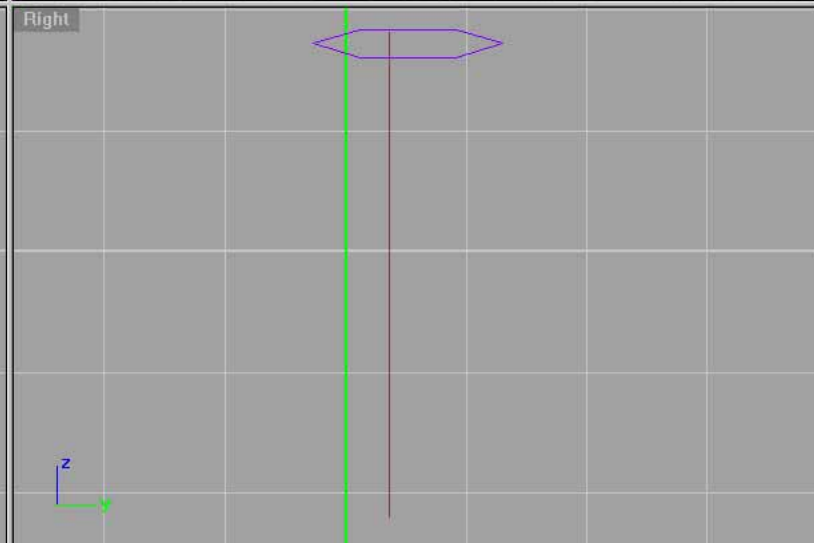
Perspective



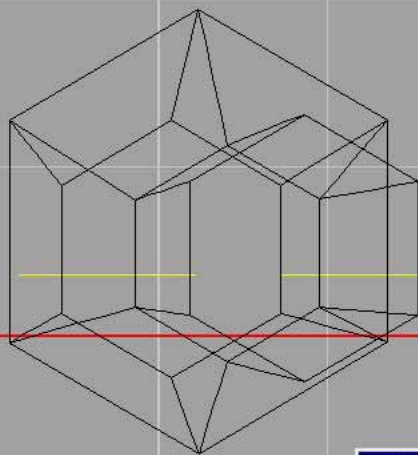
Front



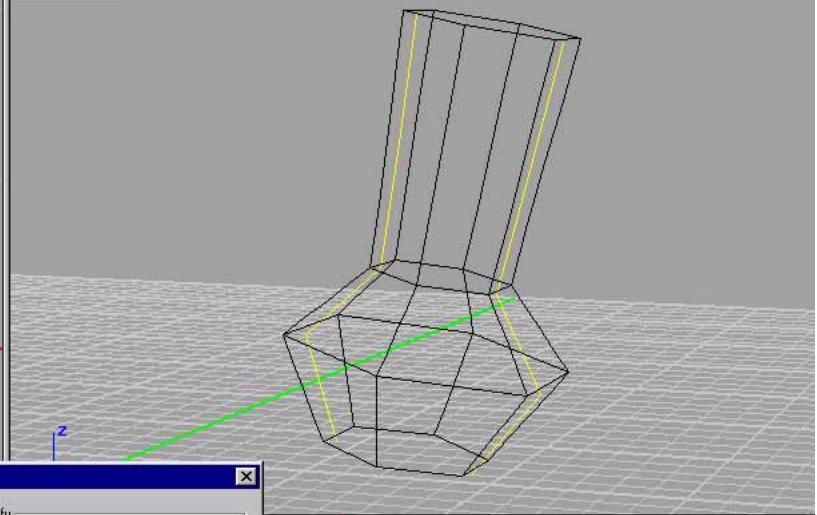
Right



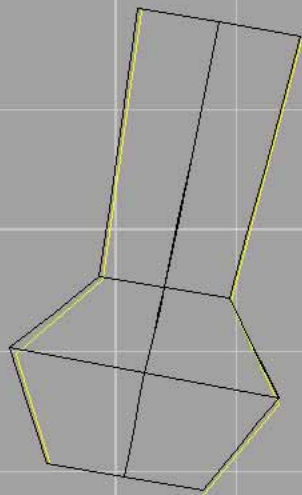
Top



Perspective



Front



Sweep 2 Rails Options

Simplify

- ☐ Maintain height
☐ Closed sweep
☐ Shaded preview

☒ Do not simplify

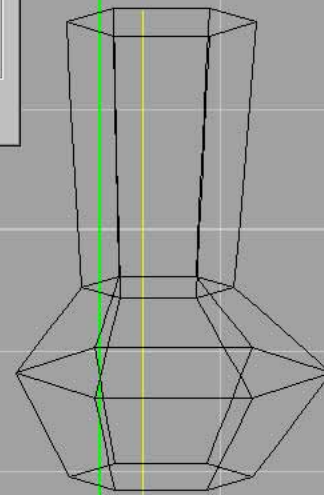
☐ Rebuild with 10 control points
☐ Refit within 0.01 units

OK

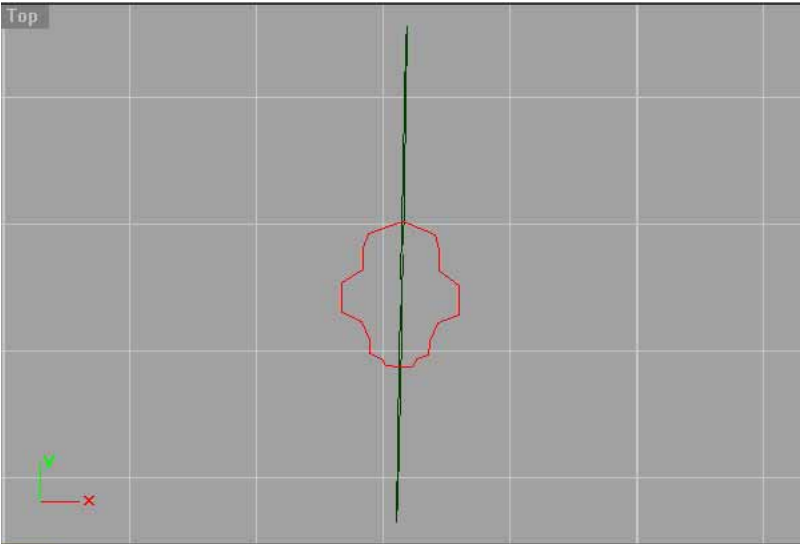
Cancel

Preview

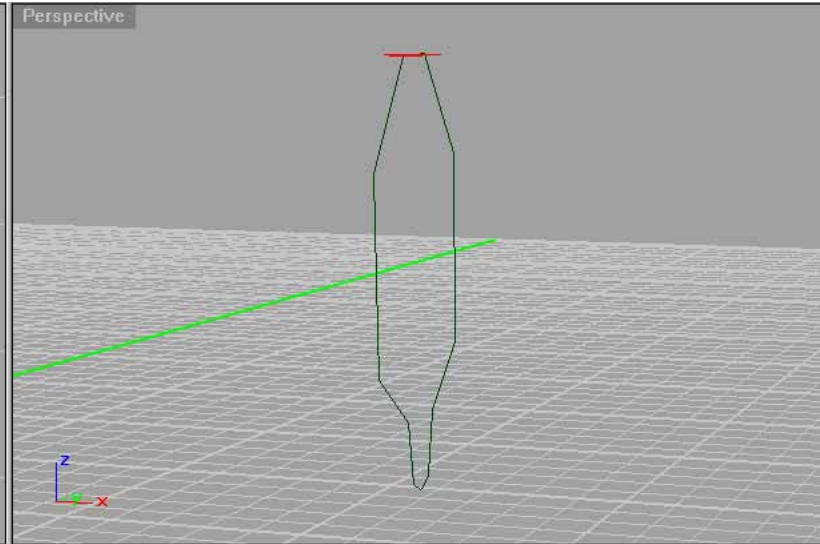
Help



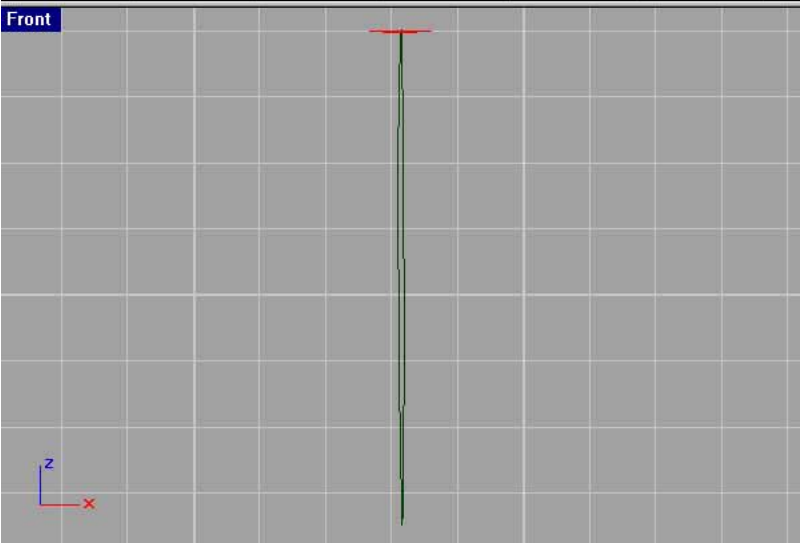
Top



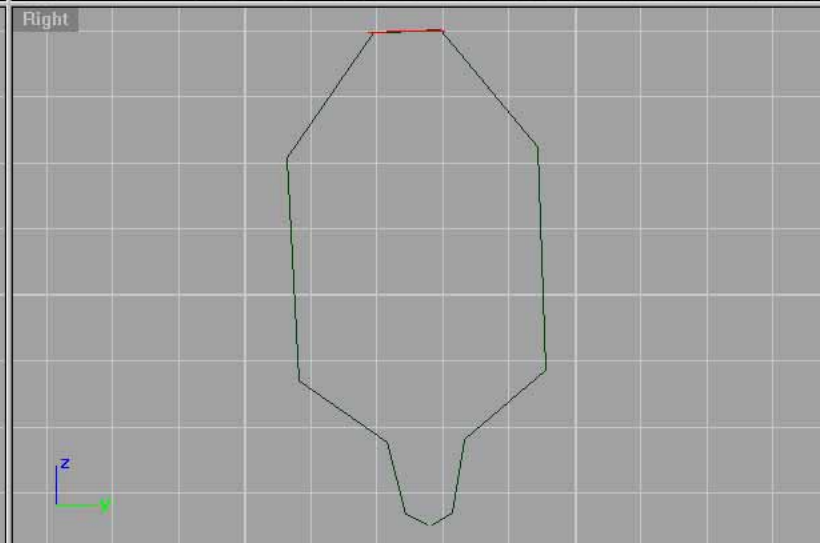
Perspective



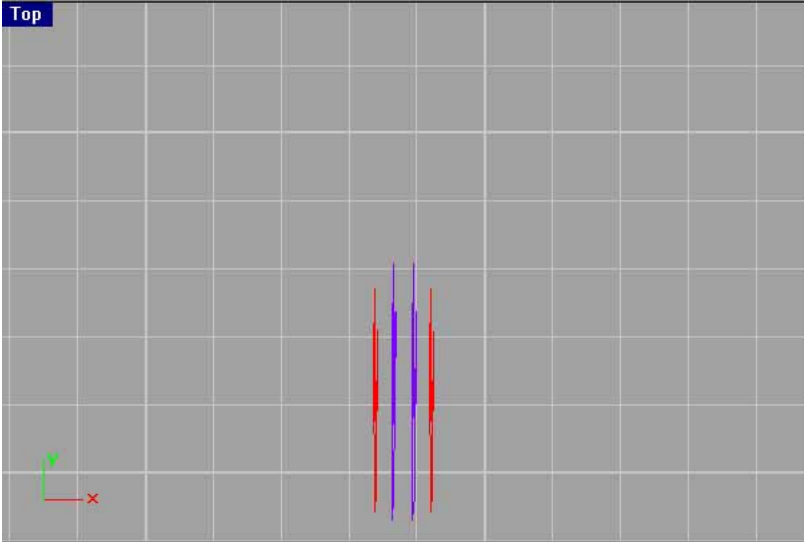
Front



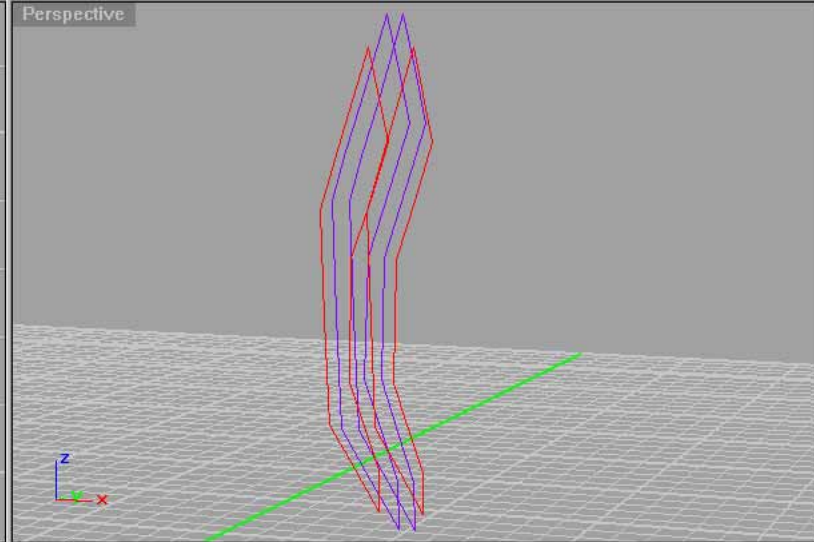
Right



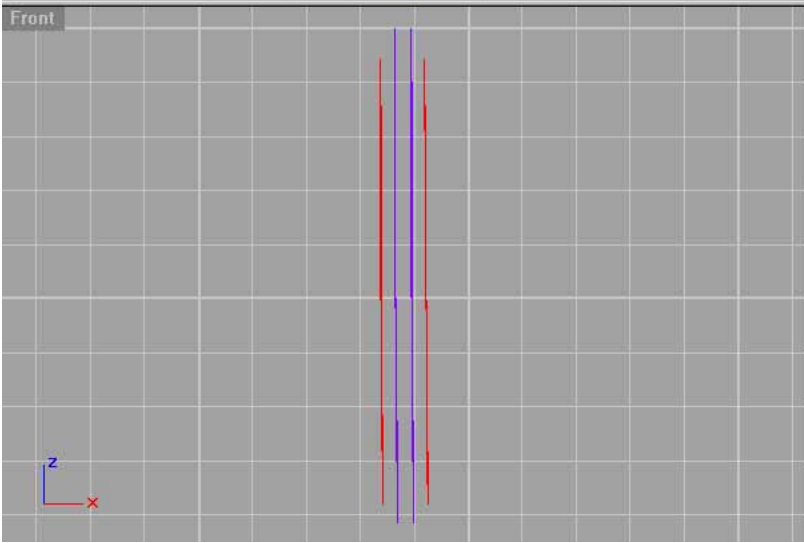
Top



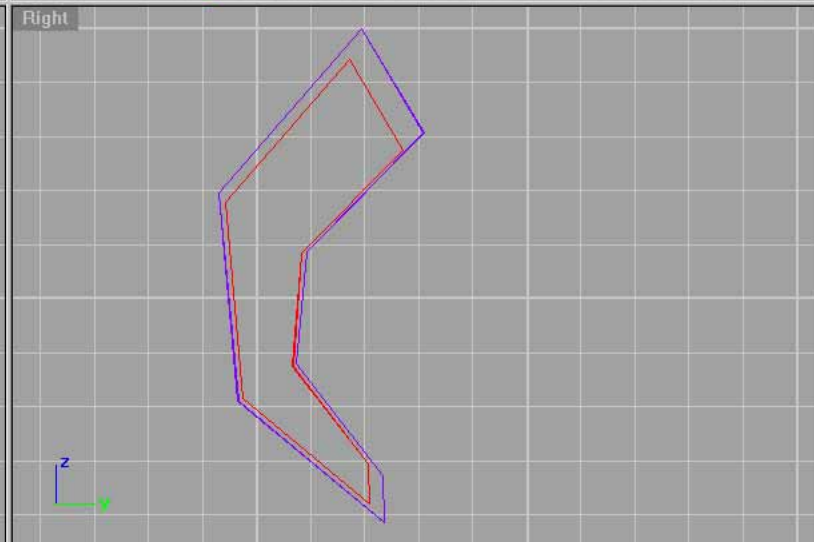
Perspective



Front



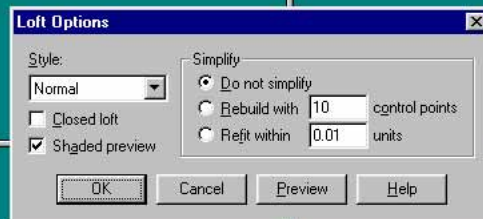
Right



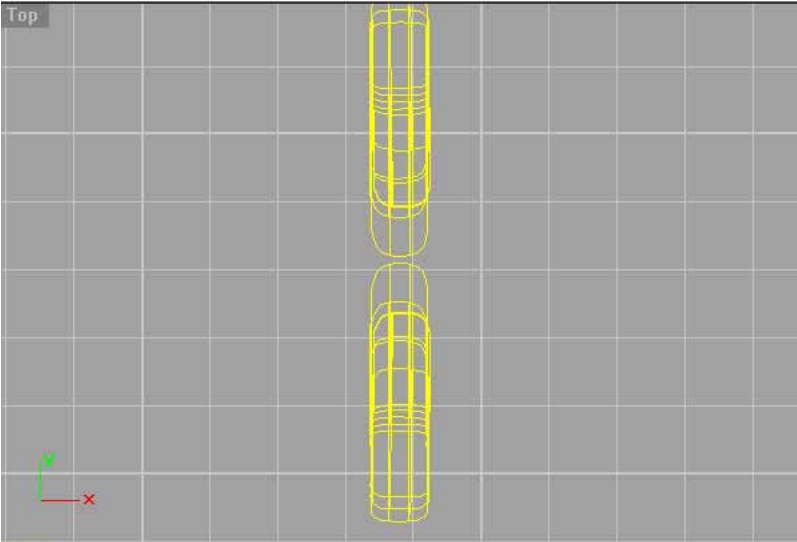
Top

Perspective

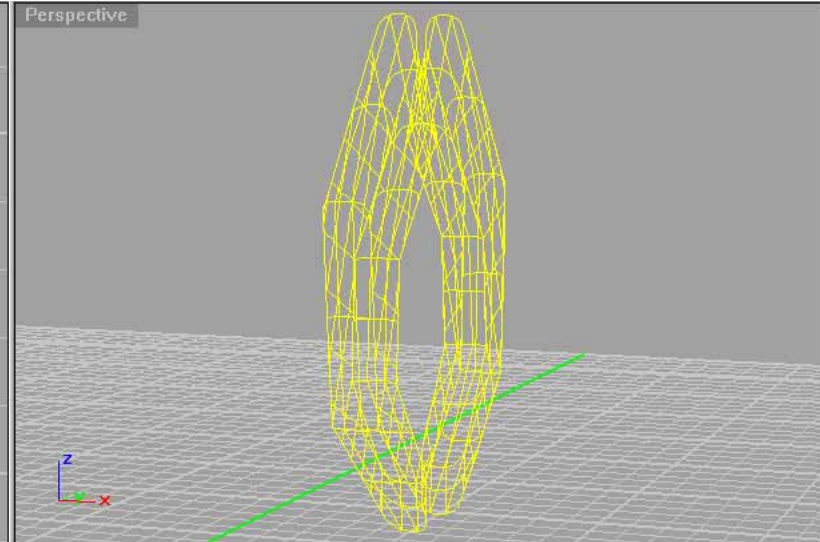
Front



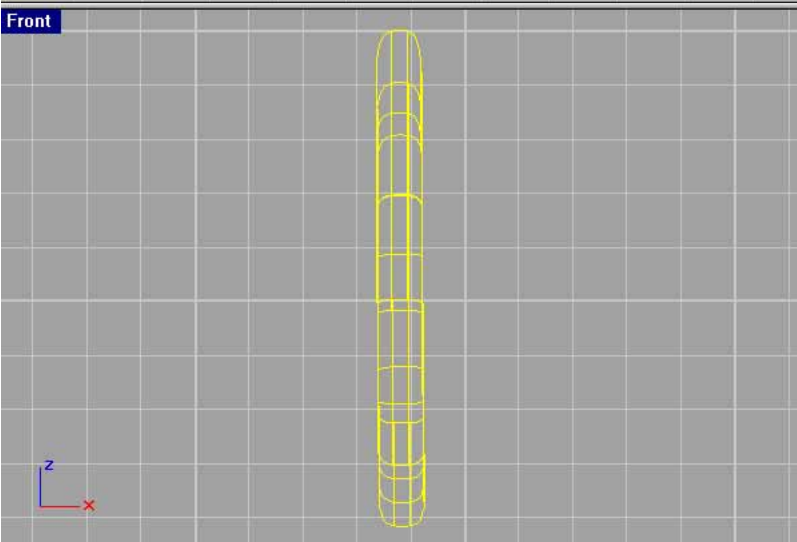
Top



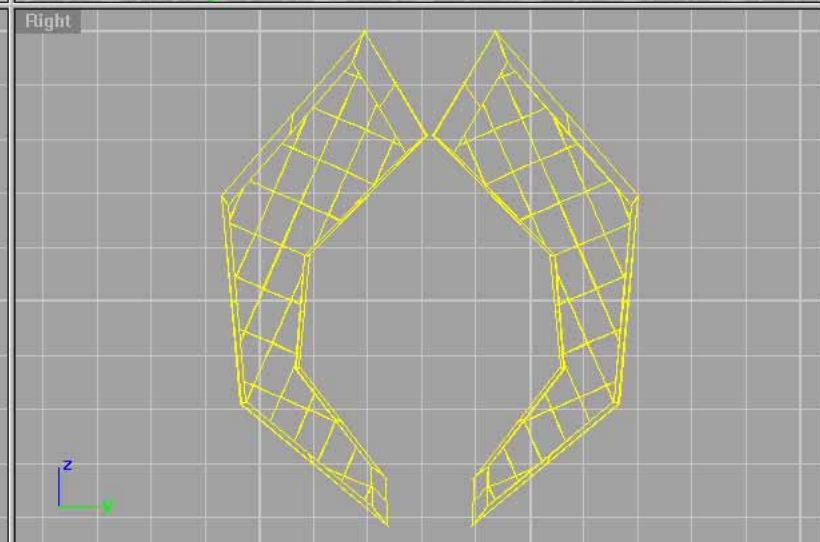
Perspective



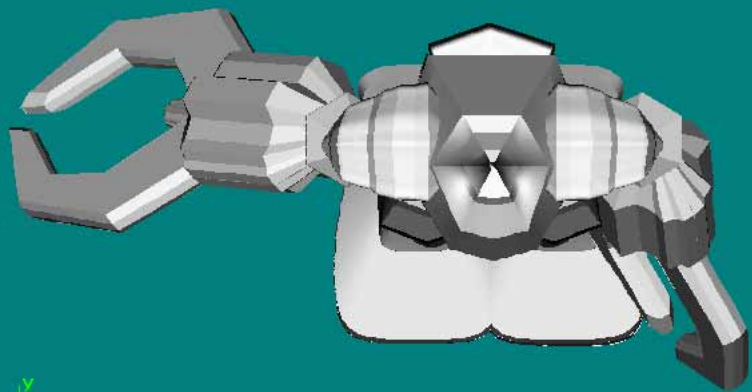
Front



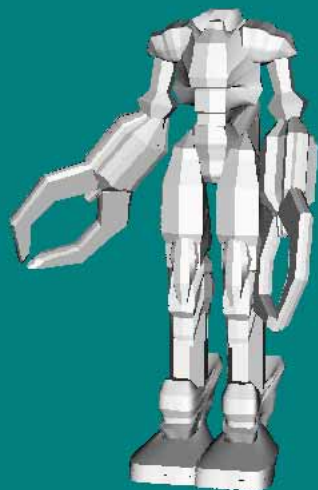
Right



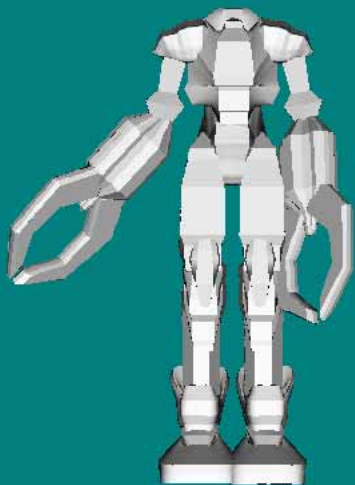
Top



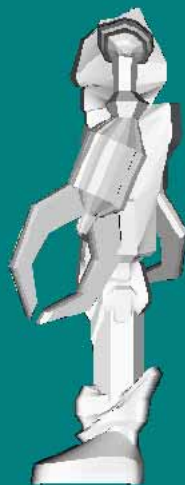
Perspective



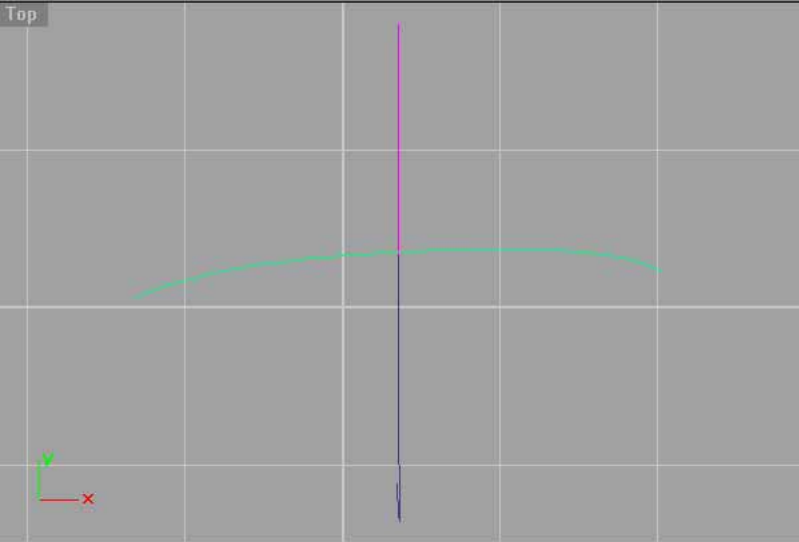
Front



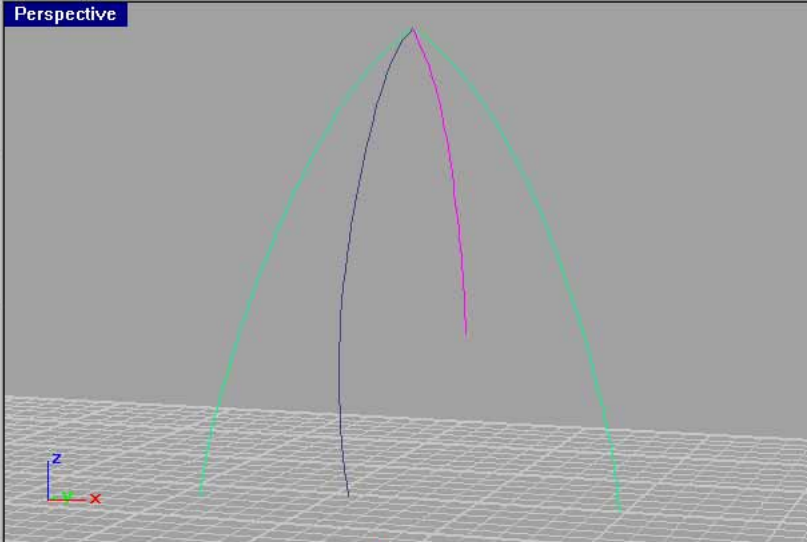
Right



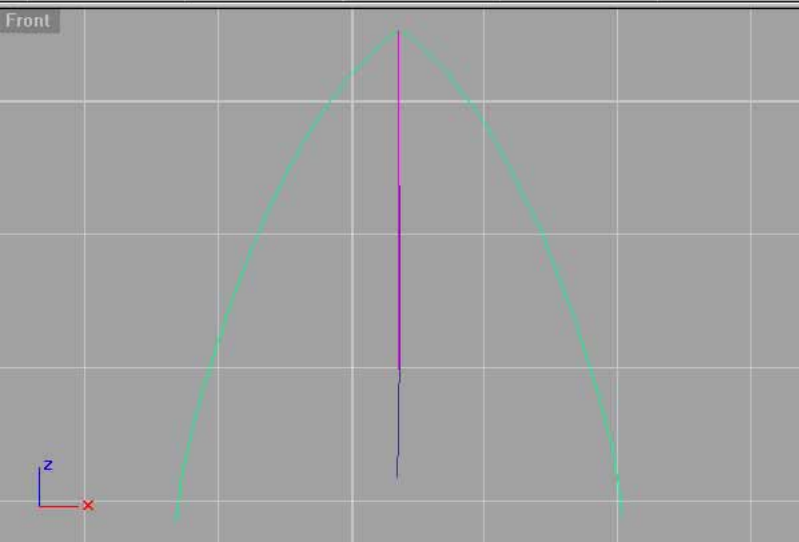
Top



Perspective



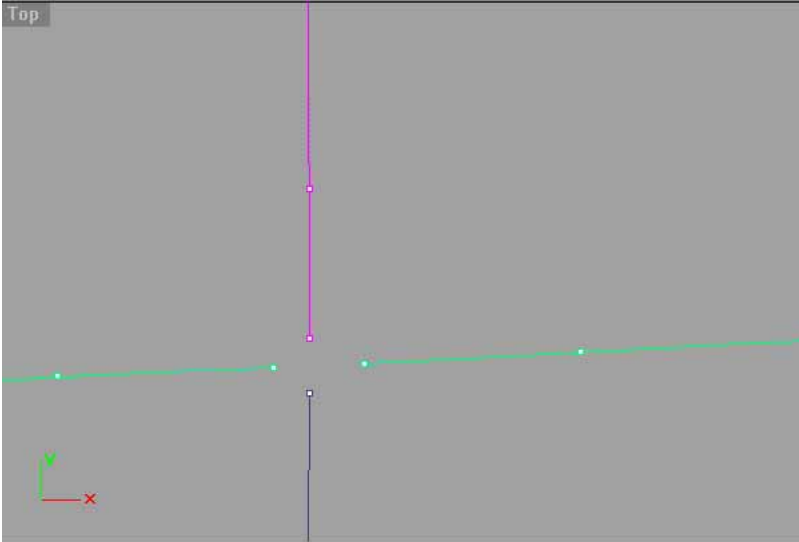
Front



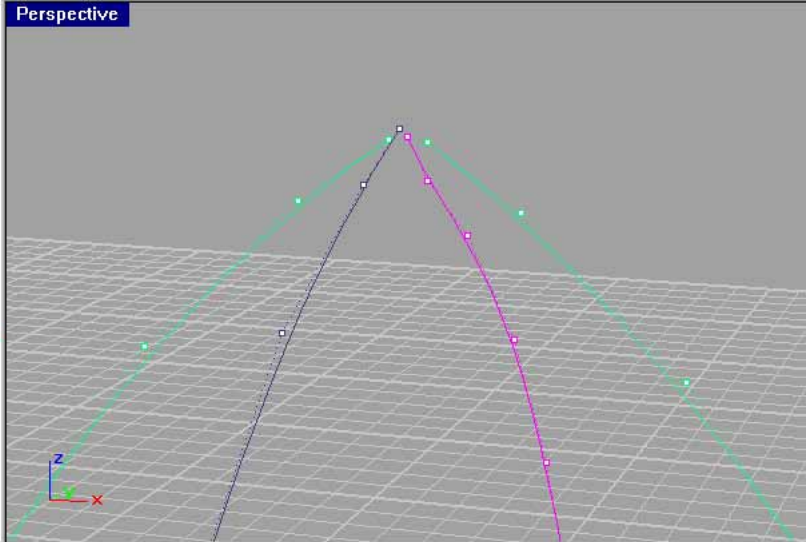
Right



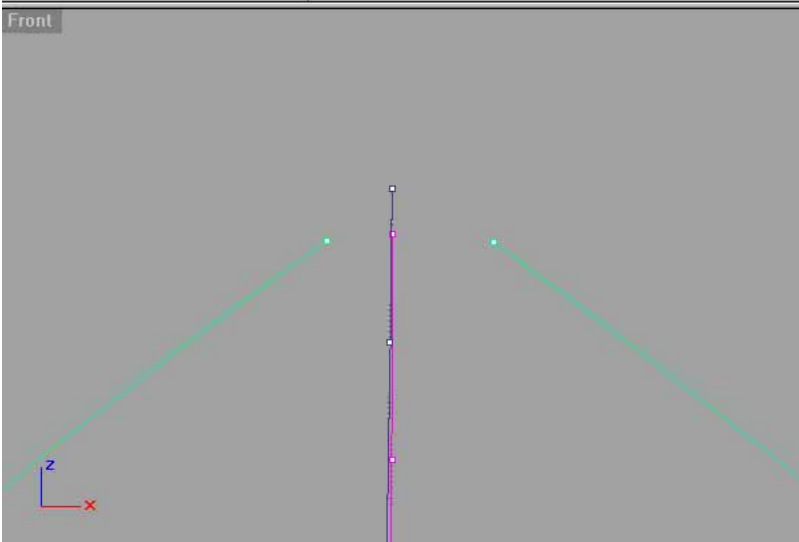
Top



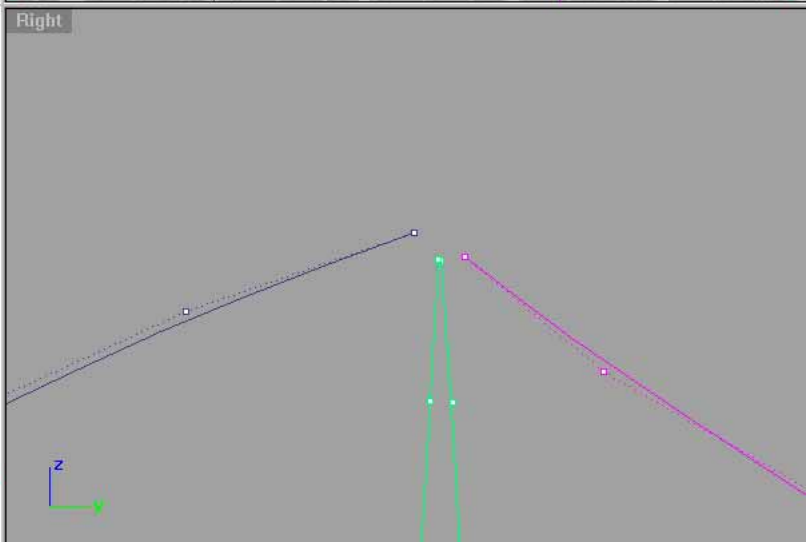
Perspective



Front



Right



☐ snap ✕

☐ End

☐ Near

☒ Point

☐ Mid

☐ Cen

☐ Int

☐ Perp

☐ Tan

☐ Quad

☐ Project

☐ Lock

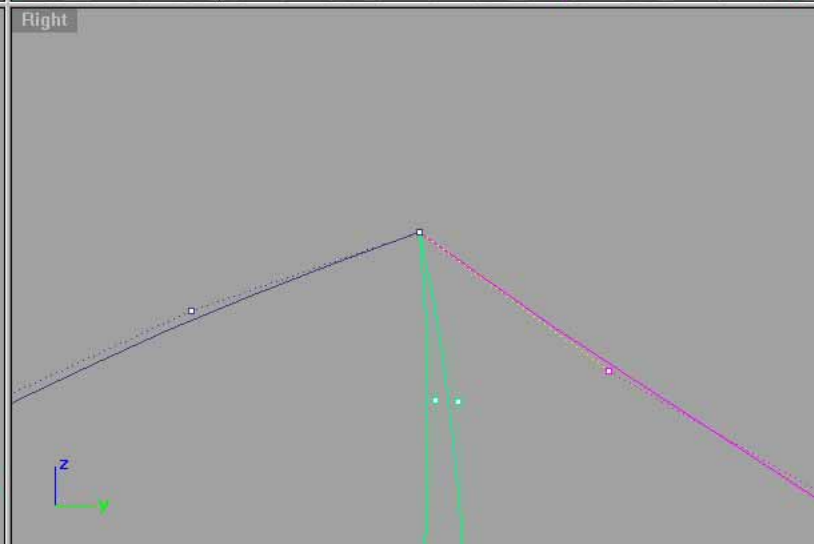
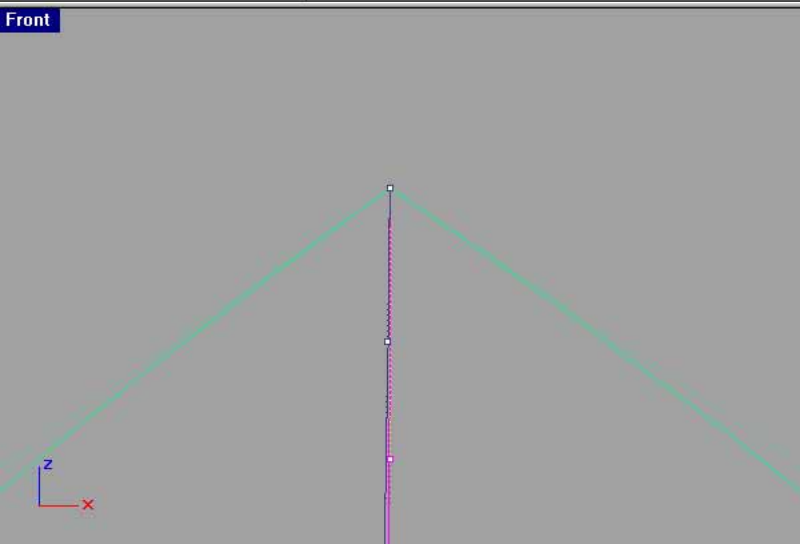
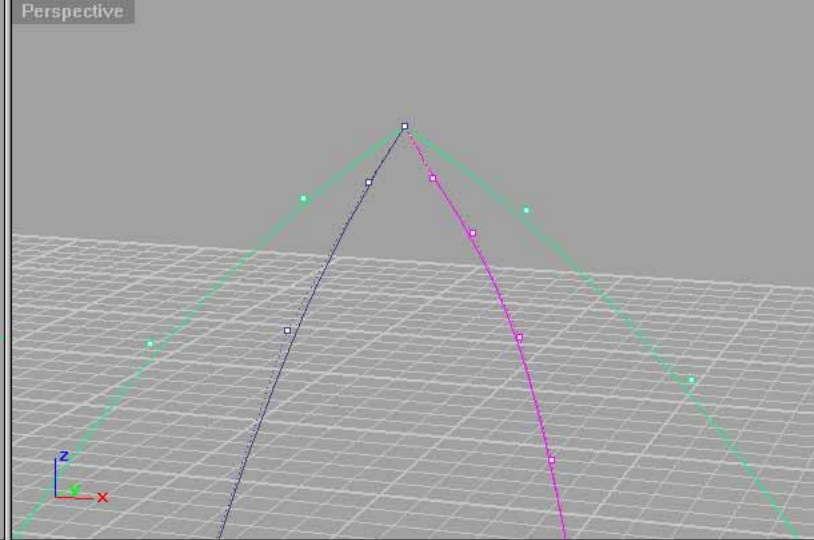
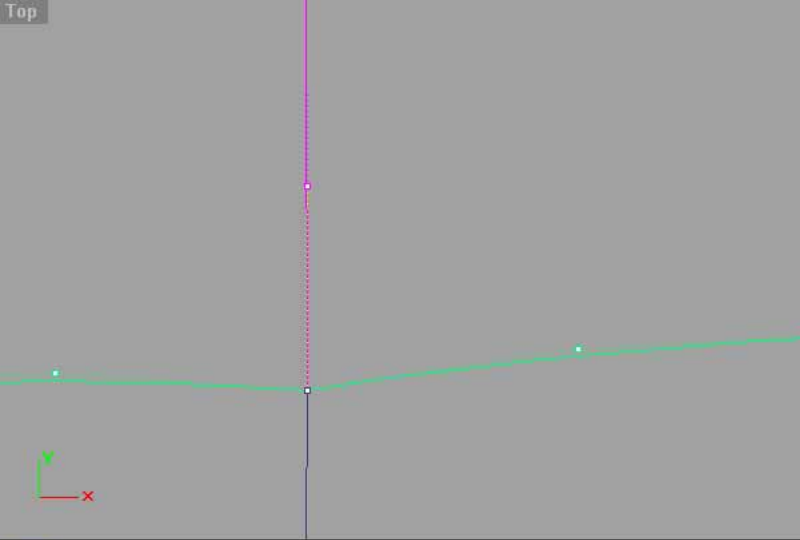
 Default

Snap

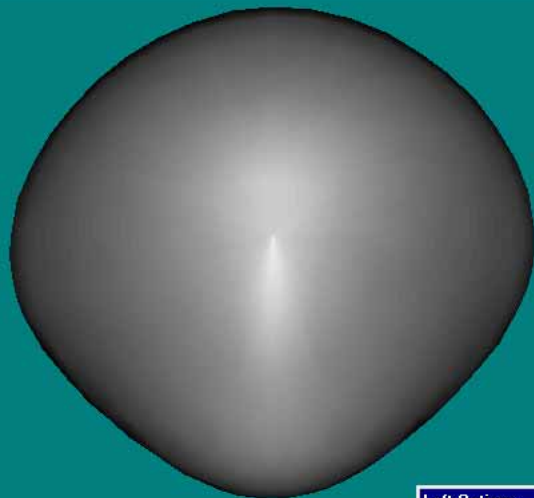
Ortho

Planar

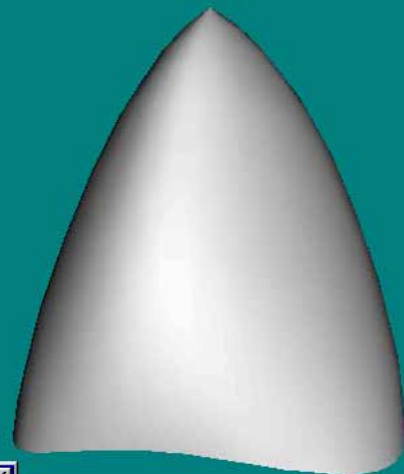
Osnap



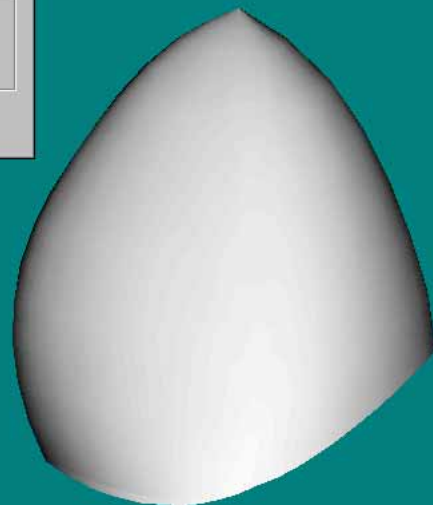
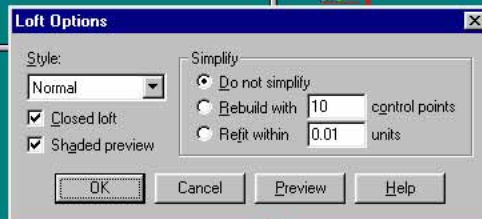
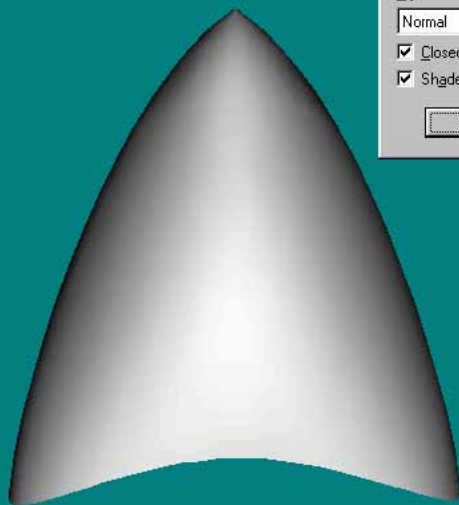
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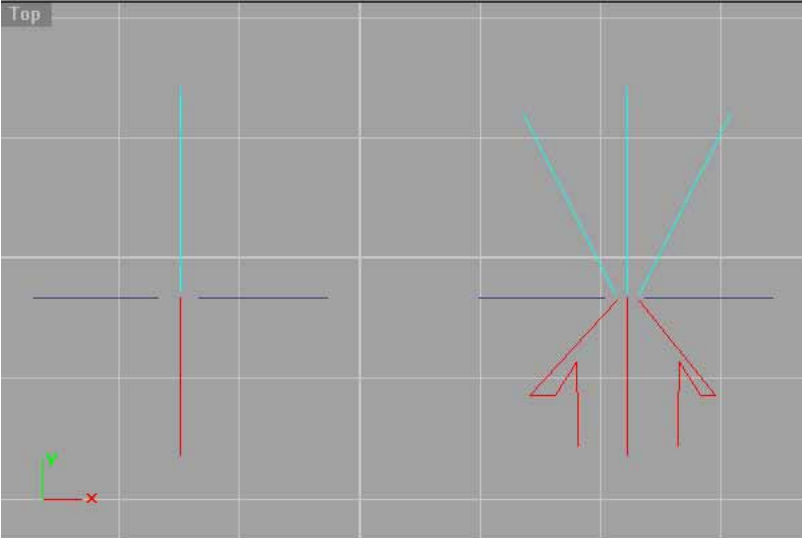
Perspective



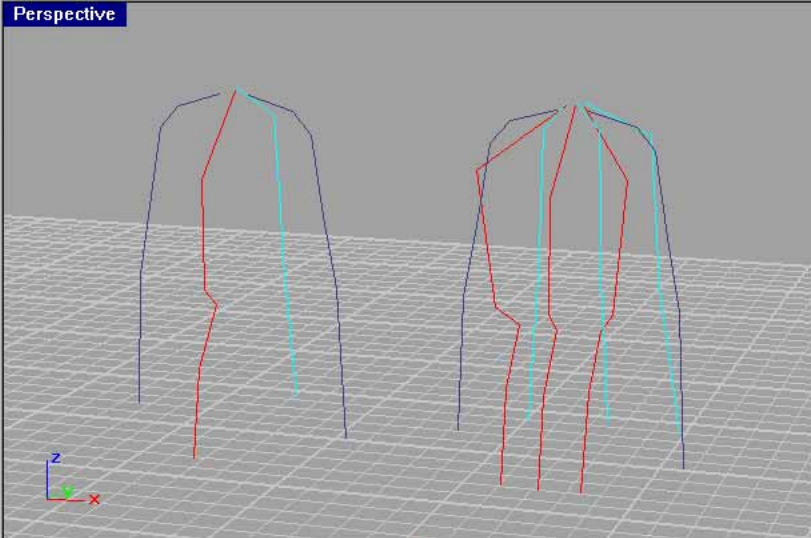
Front



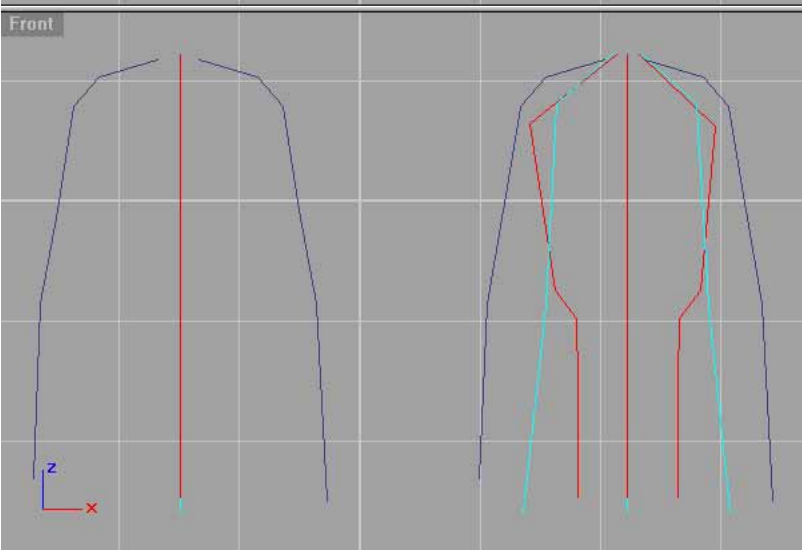
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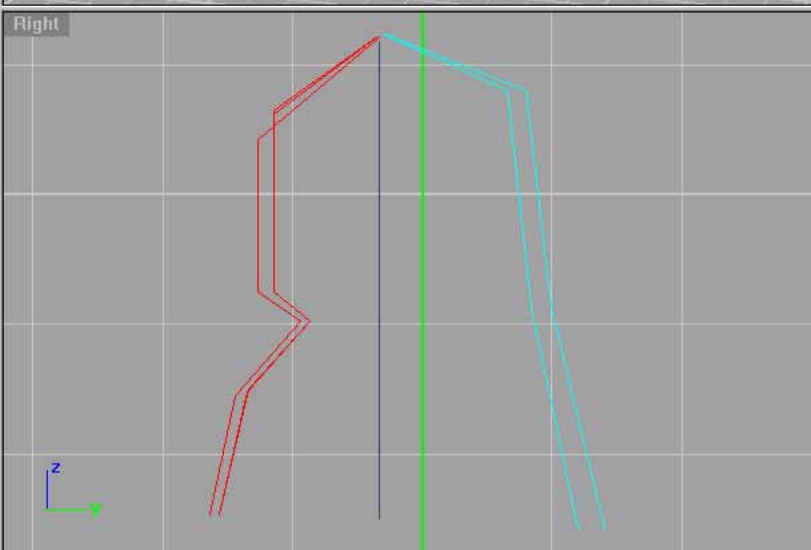
Perspective

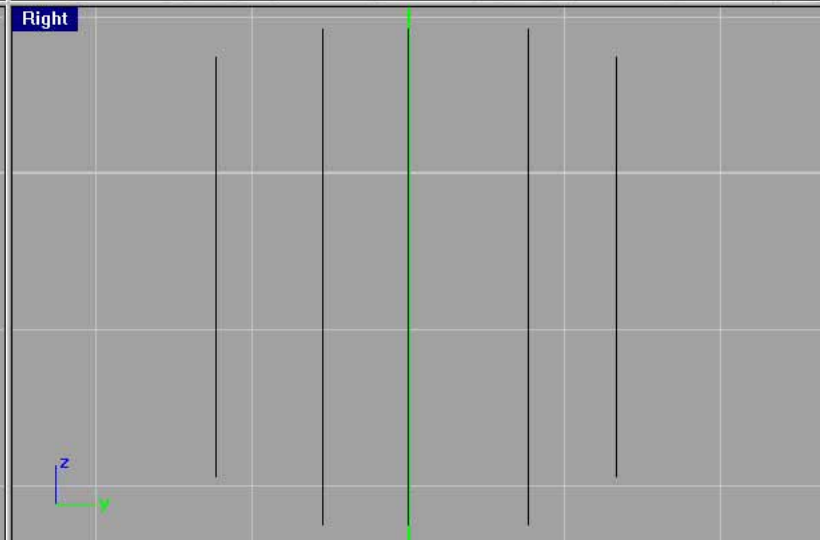
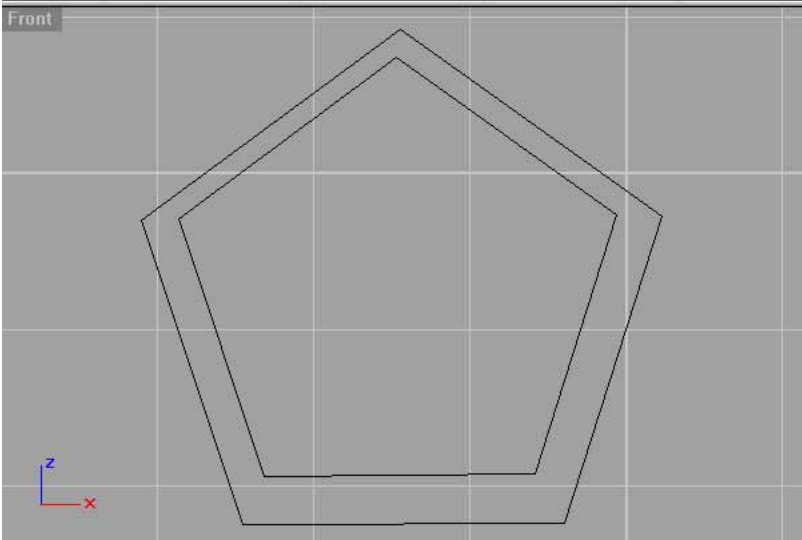
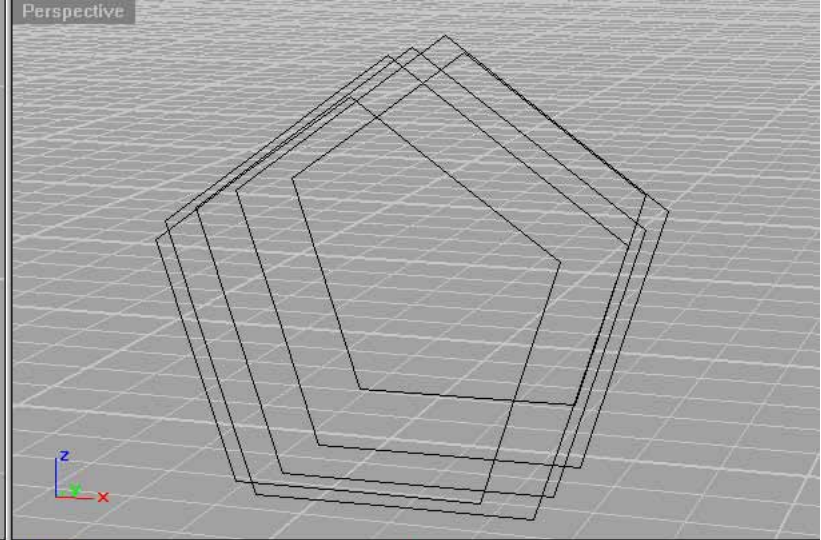
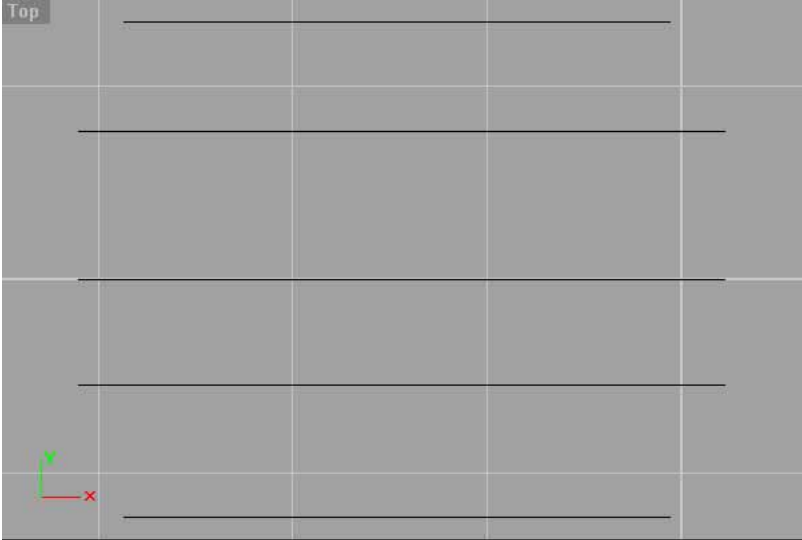


Front

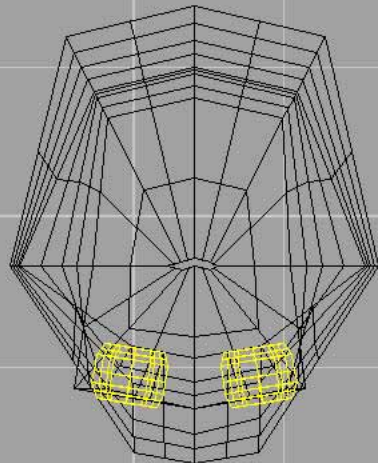


Right

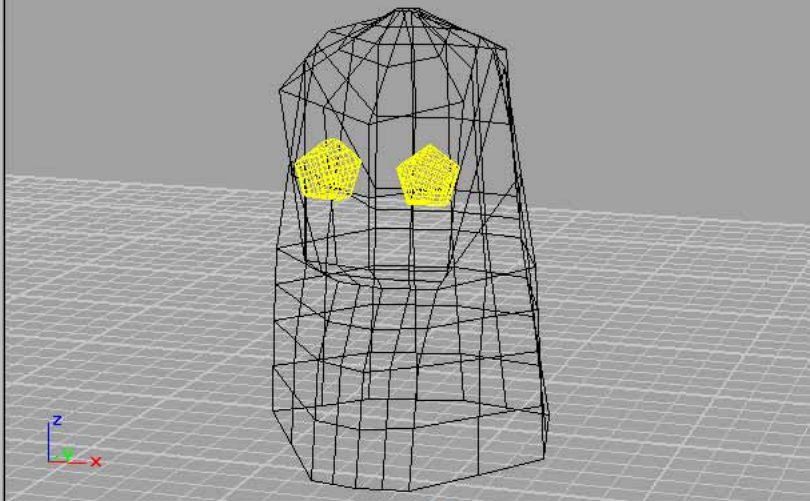




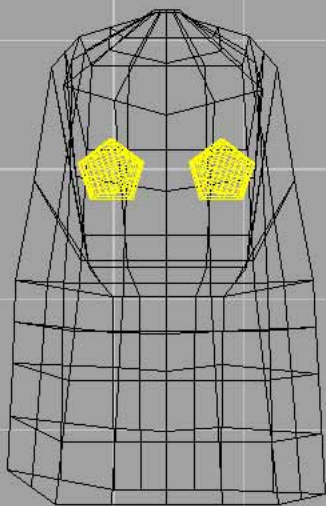
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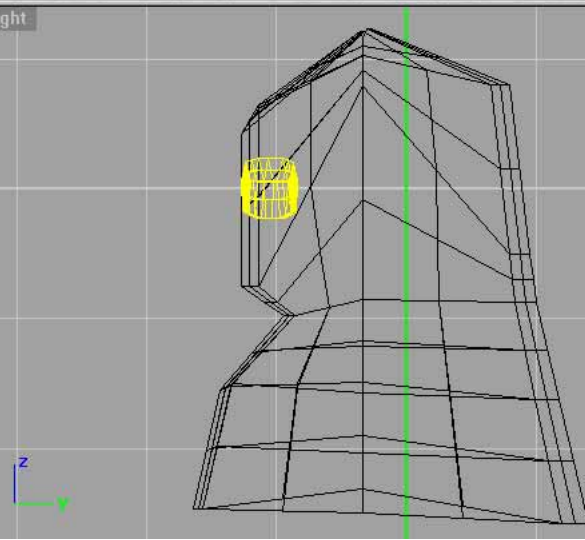
Perspective



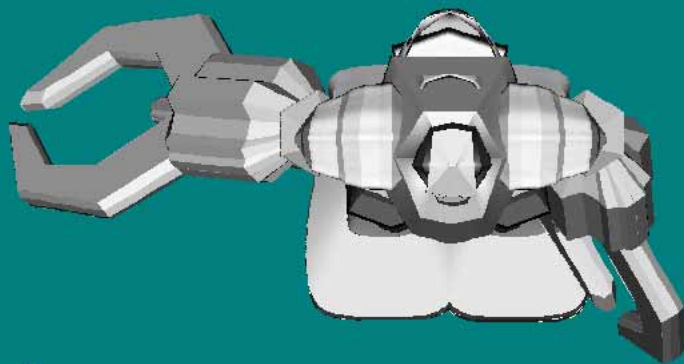
Front



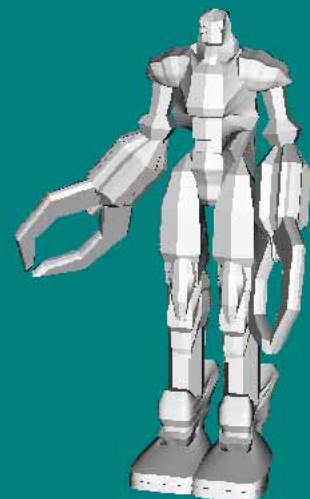
Right



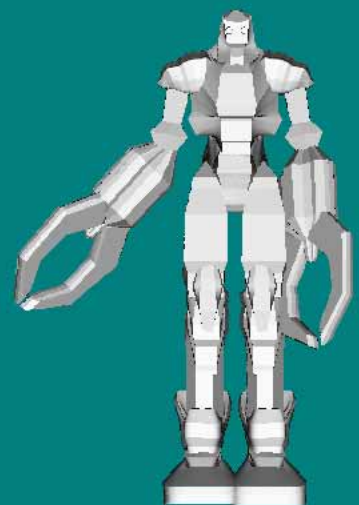
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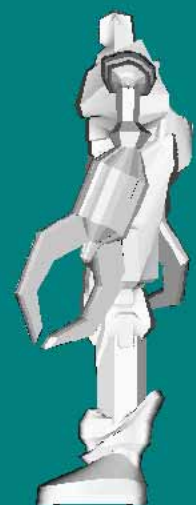
Perspective



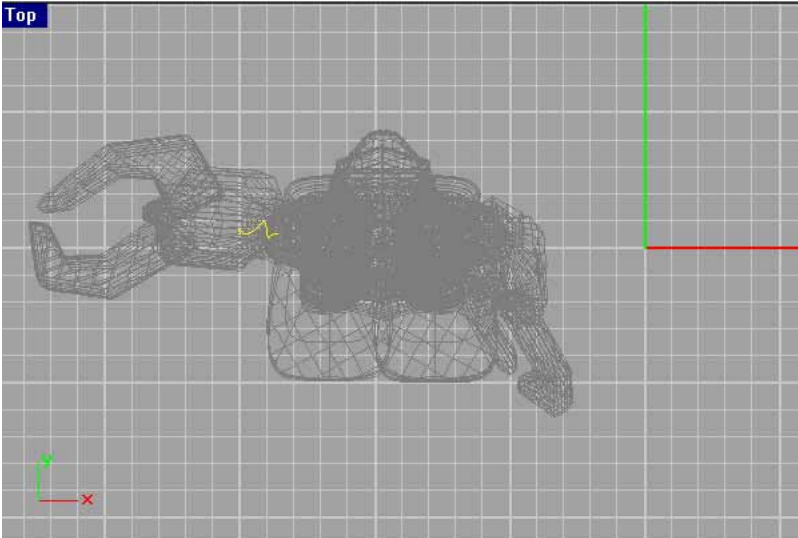
Front



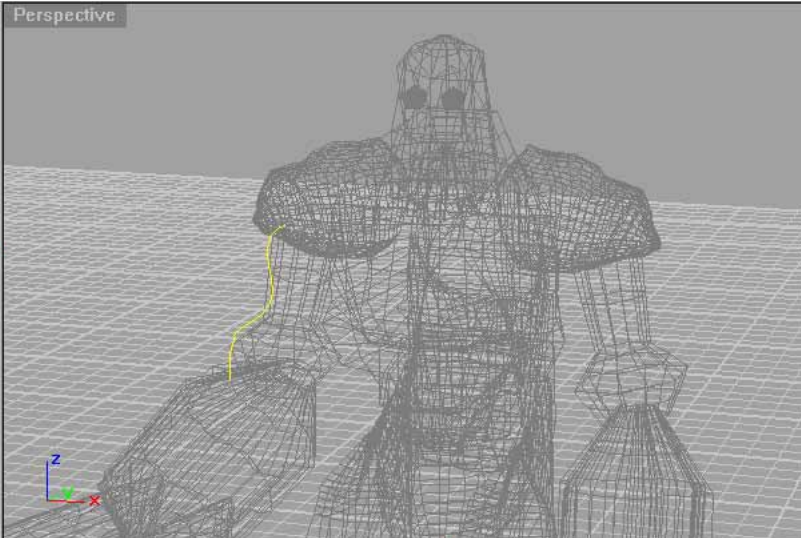
Right



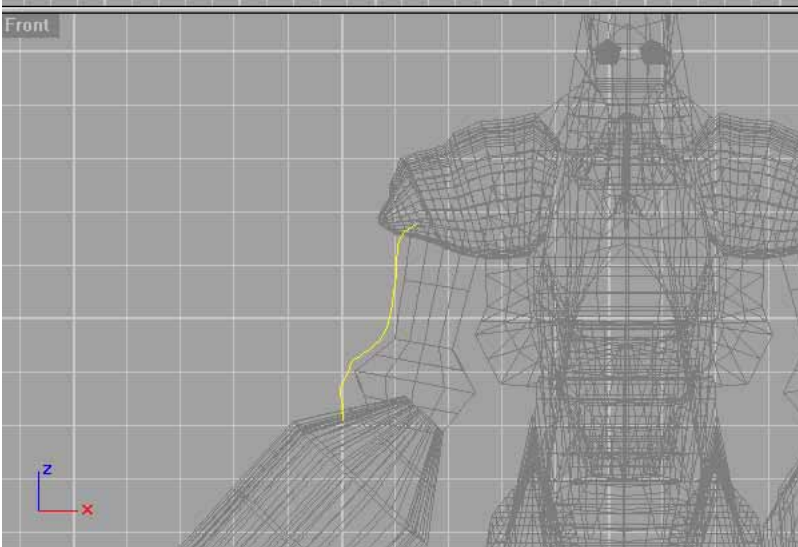
Top



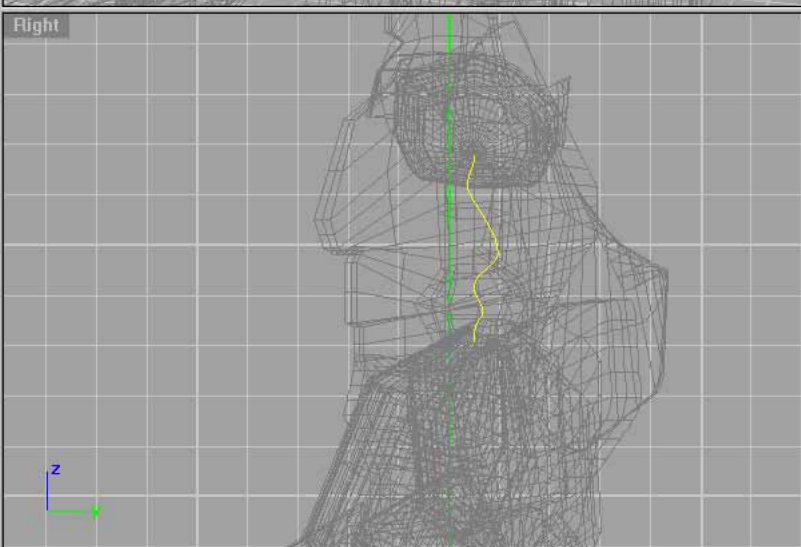
Perspective

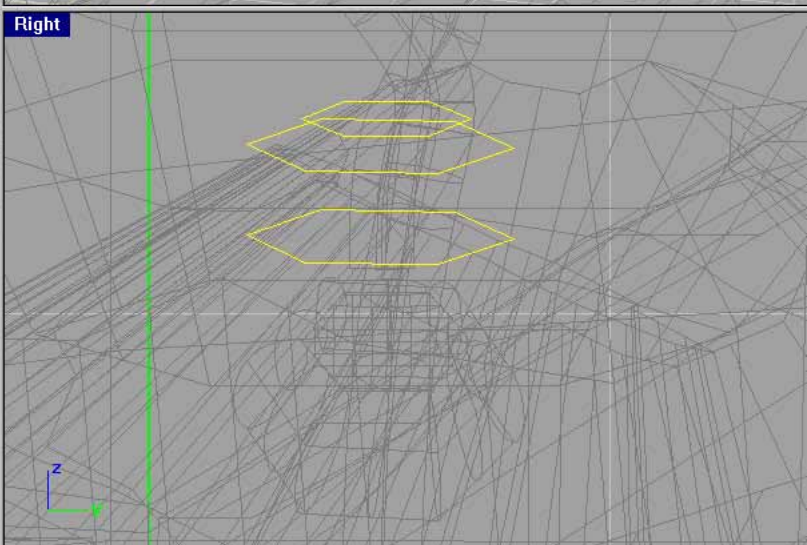
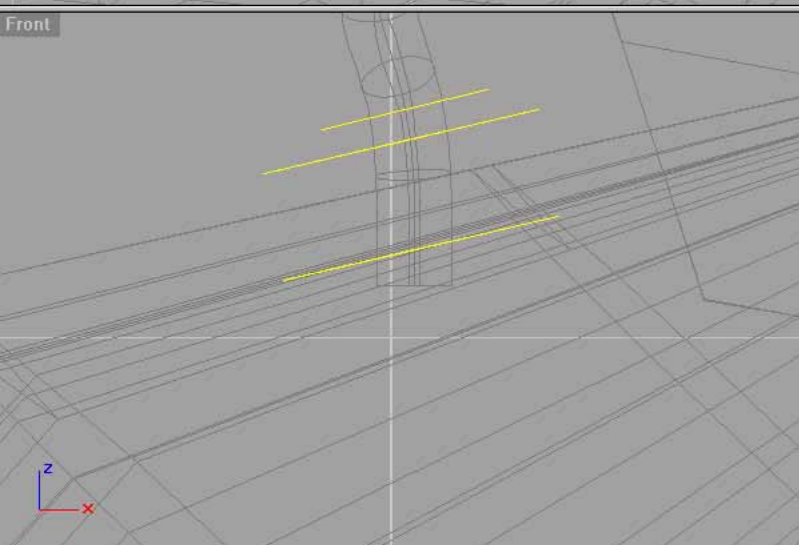
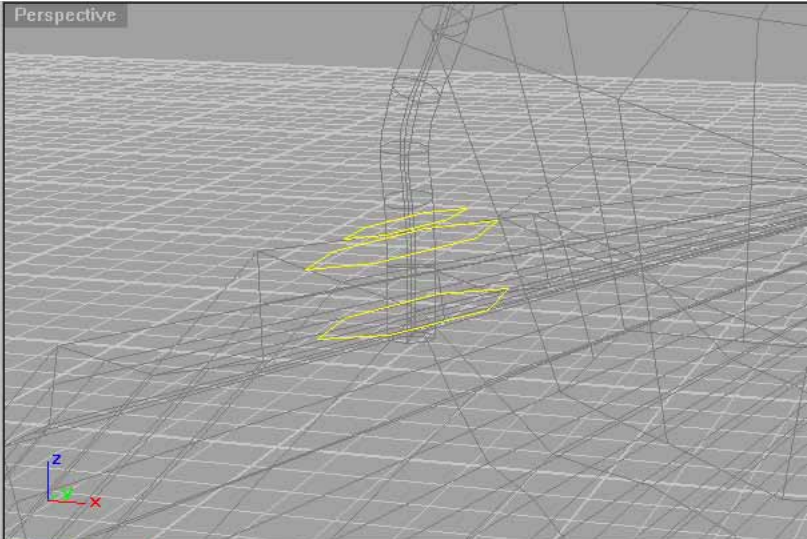
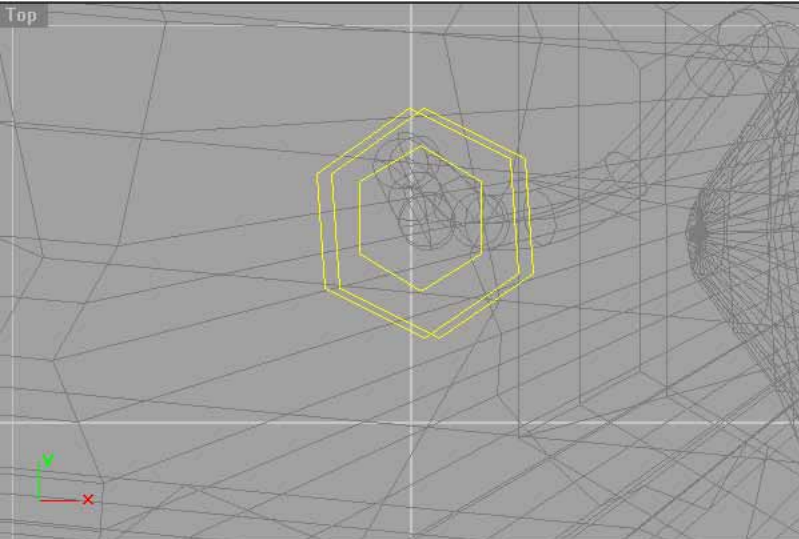


Front



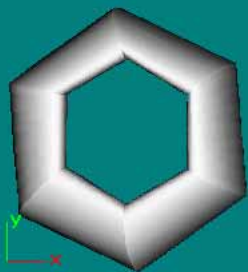
Flight



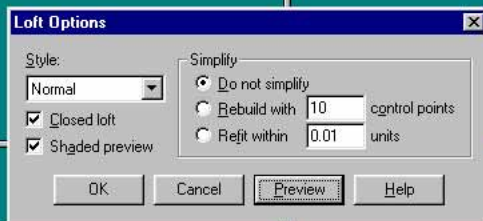


Top

Perspective



Front



Vergos 10 Dig Grappler



Modeled by Ryan W. Knope March 10th, 1999