

Creating plants and flowers

Mastering 3D Graphics ~ issue #1

in Lightwave Chris MacDonald

I can't tell you how many times I've been asked, "How did you make those flowers?" or "Can you tell me how to model a good plant?" This is probably for a couple reasons. First, when an image contains plants and/or flowers that are pleasing to the eye, they immediately stand out since it is still somewhat uncommon to find photorealistic greenery in images. Second, I also think that it's still pretty daunting for a lot of people when they see tons of little leaves and all of the parts that make up a flower or a plant.

In this tutorial, I hope to demonstrate how easy it is to create detailed flowers and plants that will add a great deal to an image (assuming the image calls for them, of course). This tutorial requires a thorough awareness of the tools in Lightwave and Photoshop as well as a basic knowledge of how to use them.



When to Use Greenery

The most common place to find greenery is going to be outside. One would be hard pressed to go anywhere outside and not see some sort of vegetation, whether it be the giant oak tree in your backyard or the nagging weeds growing in the cracks of the sidewalk. For the most part, an outdoor image that doesn't contain some sort of greenery is probably going to look like it's missing something. So we know that most outdoor scenes need greenery, but what about indoor scenes?

Now, obviously you're not going to place a big pot of flowers on the console of your intergalactic space cruiser. However, there are many other places in life where various kinds of plants or flowers can be found. Take a typical office building for example. The first thing that comes to mind probably isn't the fake tree sitting in the corner. However, if you take a look at 75% of the office buildings in America, you're most likely going to find some sort of foliage or flora. The reason for this is that plants and flowers give indoor environments a much more pleasant atmosphere. In a 3D image, they greatly reduce the perfect, "sterile" look commonly found in many indoor scenes. They also add tremendous photorealistic credibility to the scene.

Take a look at [Figure 1](#). This is a good example of how plants add life to a scene and really increase the overall realism of the image.

Plants and flowers can add a lot to an image, so a good 3D artist shouldn't be afraid to include them where they would naturally be found in reality. OK, enough with the lecture, let's make some flowers!

Gathering Your Reference Material

The first basic rule of modeling anything found in life is to have its real-world counterpart available for study (or



Figure 1: Example of plants in a scene.

at least a picture of it). Since we'll be creating lilies in this tutorial, a picture will suffice. Take a look at the reference image in [Figure 2](#).

Notice the way that the petals are curved. Also look at the arrangement of the leaves along the stem. They appear to be staggered down the stem almost all the way down to the very bottom. We're going to slightly alter our lily so the flowers and buds will not be angled downwards as they are in the picture.

Now let's move on to the fun part - Modeling!



Figure 2: Reference image.

The Modeling

We'll be doing things a little differently in this tutorial than you are probably used to. Instead of assembling everything in Modeler, we'll only be modeling the parts. Then, we'll load them into Layout, surface them, clone them as necessary, and assemble the actual objects. By doing it this way, we can accurately apply texture maps and still be able to load the entire lily object into a scene as many times as we want by using the 'Load From Scene' command in the objects panel.

Creating the Flower

Let's open up Modeler and turn on the OpenGL Smooth Shaded preview. I have my units set to Metric, so for this tutorial you'll want to do the same. The first thing that we'll create will be the actual flower. If you had actually scanned in various views of lilies or sketched out your own, you could load it in as a background image. But for this tutorial we'll just wing it.

Let's get started.

- 1) Drag out a rectangular box in the top view that's about 800mm long on the 'Z' axis and roughly 250mm wide on the 'X' axis. Before you hit <enter> to create the

box, open up the numeric options and give it two segments along the 'Z' axis. All right, now hit 'OK' and make the box.

- 2) Now, in the Surfaces panel, turn on 'Double-sided' since we'll need to be able to view this from all directions. Then subdivide the box using the Faceted setting. Now select each row of points starting at the top working down and resize them along the 'X' axis until you get a shape similar to the pre-Metaformed petal in [Figure 3](#).

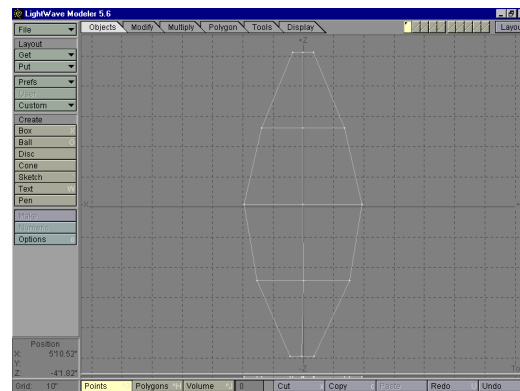


Figure 3: The petal before Metaforming and reshaping.

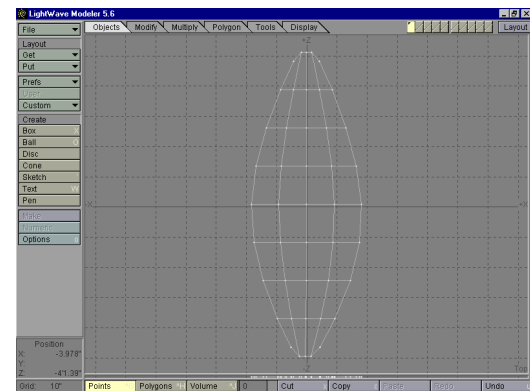


Figure 4: The five columns of points.

- 3) This next part is a little tricky, so pay close attention. First, switch to MetaNURBS mode and Metaform the petal one time. What we will do now is give the petal some shape. You can see in [Figure 4](#) that the petal has five columns of

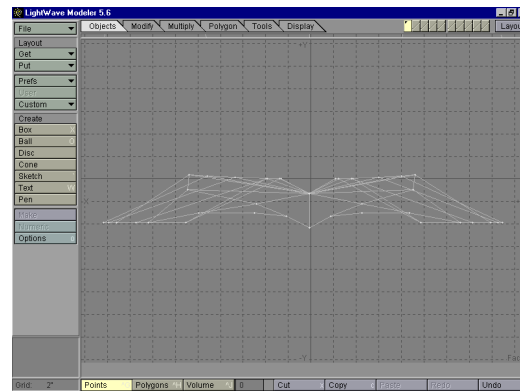


Figure 5: Petal in face view.

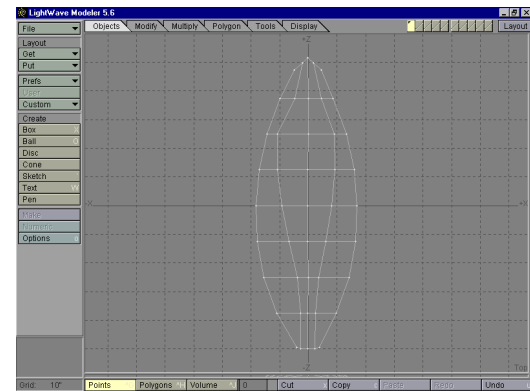


Figure 6: Tweaking the shape of the petal.

little bit on the 'Y' axis. This will be the center crease of the petal. Now deselect those points and select the outside column of points on each side of the petal and drag them down slightly farther than the center column. At this point, the face view should look like a squashed 'M' as shown in [Figure 5](#).

- 3) Now rearrange the two columns of 'in-between' points in the top view so that they are closer together towards the base of the petal and further apart up towards the tip. [Figure 6](#) shows my results using the Taper 2 tool. The point in doing this is to accentuate the center crease near the base of the petal while making it less pronounced towards the tip. If you like, you may now adjust the points towards the tip of the petal so it ends in a tiny droop. Be careful not to get too crazy with the droop though, because now we're going to add a bend to the entire petal so that it has a nice arch to it.

- 4) Before we bend it, save the unfinished model as 'metapetal.lwo'. We will use this basic shape later on when we make the leaves.

Now we're ready to use the Bend tool. Check the settings first just to make sure that the "sense" is set to positive. In your face view, apply about a 45° bend to it. This gives the petal a nice flowing curve to it, just as it would have in nature. Rotate the petal so that it's relatively parallel to the 'Y' plane. The easiest way to do this is to numerically rotate it 22.5° along the 'X' axis. The petal needs to be in this position so that when we go to texture it, we'll be able to apply a detailed planar image map on the 'Y' axis. Also align the base of the petal with the origin (the intersection of all three axes) in all views. This is done so when the model is saved, the pivot point will be at the base of the petal for accurate rotation in layout. See [Figure 7](#) for a visual on this.

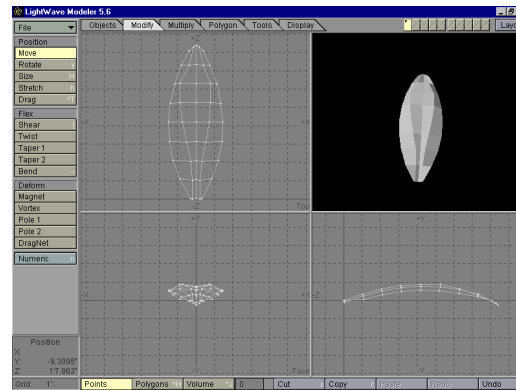


Figure 7: Applying the first bend.

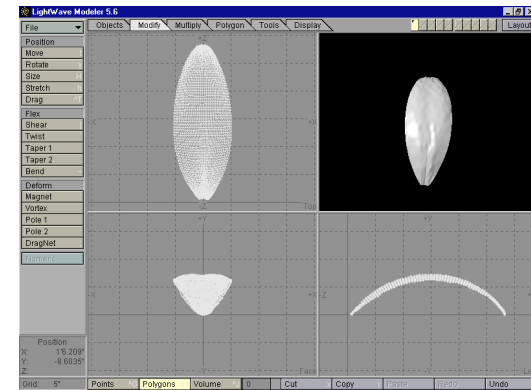


Figure 8: Final petal, bent and aligned with origin.

5) Now, simply freeze the MetaNURBS object with a patch division of four. OK, looking at our petal now, it looks a little too smooth. The key is to add a bit of randomness to the petal surface. The easiest way to do this is to apply Jitter. I applied 5mm of Gaussian Jitter on the 'Y' axis, but feel free to experiment. After Jittering, Metaform the petal once to smooth it all out. Now that we've Jittered it, the final step in modeling the petal is to bend the petal one more time. Bend it 60° and then rotate it 30° to get it parallel again.

6) Actually, I lied. There's one more step. We need to Triple the polygons so we don't get any non-planar errors when rendering the flowers in layout. Before we finish up the flower, save the single petal as "petal.lwo". We will use this object later on in Photoshop to create the petal texture. Now that we have our basic petal, clone it five times around the origin to create the whole flower (Figure 9.) You might want to vary the pitch of each so that they don't intersect. Be sure to assign a proper surface name to this object. I'm going to call it

"Petal_P_Y" since I'll be applying a planar image map on the 'Y' axis. Make sure that you turn on Smoothing. Actually, from now on, smoothing will need to be turned on for every surface that we will make.

Now that we have our first object modeled, we're going to want to save it in a directory called something like 'lily'. This will be where we'll save all our objects. Go ahead and save the flower as 'flower.lwo'. Leave the flower in the first layer of Modeler, and open up a second layer.

Creating the Stamen

7) OK, now we'll model the stamen that will end up in the middle of the flower. This is very simple. Just create a cylinder (more like a pipe) with its height along

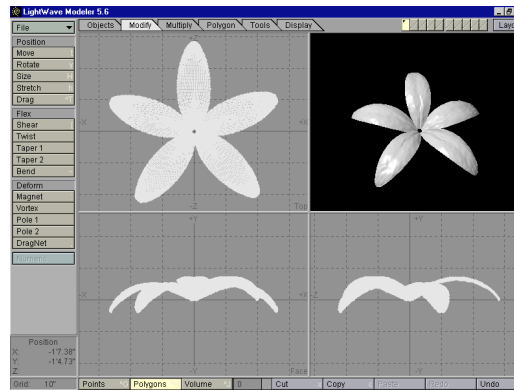


Figure 9: Petal cloned 5 times around origin.

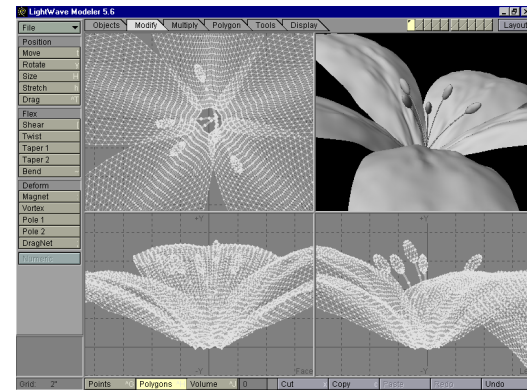


Figure 10: Adding the stamen.

the 'Y' axis. Resize it as necessary to form a thin straw-like tube. Give this a surface name of 'Pollentube'. We'll be able to get away with using a procedural texture for this object so its orientation really isn't necessary in the surface name.

- 8) Create a small elliptical sphere stretched along the 'Y' axis and place it on the top of the shoot. Surface the sphere as 'Pollensphere'. Bend the whole object a little bit in the top view and rotate it so that it appears to be "growing" out of the Y plane. Now clone the stamen four or five times and give each clone a slightly different rotation. Put the petal that is in layer 1 into the background and resize the stamen so that it's sized relative to the petal just as you saw in [Figure 2](#). Paste the stamen into layer 1 and re-save the flower.

Creating the Stem

- 9) Before we can add much more to the lily, we need to have a stem. Instead of using a cylinder, we'll use a box with MetaNURBS so that we have more control over the shape. Create a long stem-like box along the

'Y' axis. Make the box roughly three meters tall and about 50mm wide on both the 'X' and the 'Z' axes. Once again, before you hit <enter>, give the box eight segments on the 'Y' axis. Go ahead and create the box, then switch to MetaNURBS mode.

- 10) Looking at our reference image, we can see that there is a slight bulge in the stem at the top just before it reaches the flower. Since we're using MetaNURBS, we can easily stretch out the top-most segment of the stem to achieve this effect. After you get the top the way you like, freeze it and align the base of the stem with the origin point in all views. Now apply a small amount of bend (as seen in [Figure 11](#)), say 15° or so and surface the stem as 'Stembig_Cyl_Y'. Then save it as 'stembig.lwo'. The reason we called it 'stembig' is

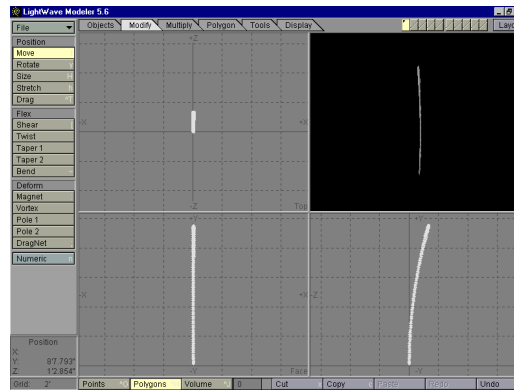


Figure 11: Bending the stem.

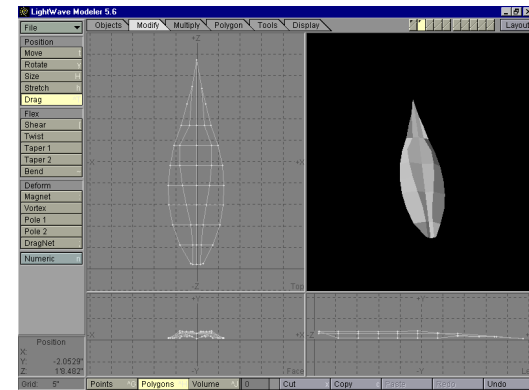


Figure 12: Accentuating the leaf tip.

because we now need to scale it down to roughly 1/3 the size of the original, surface it as 'Stemsmall_Cyl_Y' and save it as 'stemsmall.lwo'. This smaller stem will allow us to add more flowers sprouting off of the main stem.

Creating the Leaves

11) Our next step is to create the leaves. Load the model that we saved before called 'metapetal.lwo'. This will be our basic leaf shape. First, drag the point at the tip of the leaf out so that the leaf comes to more of a point than the petal did. Finish adjusting the other points around the tip so that the leaf tapers off to that end point and roughly matches [Figure 12](#).

12) The second major difference between the petal and the leaf is the width. The leaf is clearly much slenderer, so scale the leaf along the 'X' axis until it's roughly half the width of the petal. Now it's starting to look more like a leaf. Resize the entire leaf until its length is about 1.2

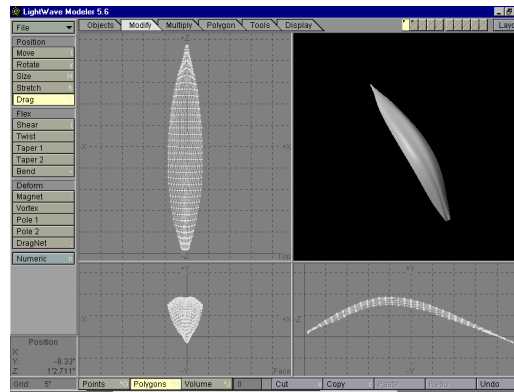


Figure 13: Final leaf model.

meters. Then apply a little Bend to the leaf in the face view, rotate it until it's parallel, freeze the Meta-NURBS object at the desired level of detail and voila! A leaf. Surface it as 'leaf_P_Y' with 'double-sided' turned on and save it as 'leaf.lwo'.

Creating the Bud

13) OK, now we have one more object to model, the bud. This is the easiest object to model. Create a rectangular box about 350mm long on the 'Y' axis and 75mm wide on the 'X' and 'Z' axes. Metaform the box once and select the nine points at the bottom. Squash them down along the 'Y' axis so that the bottom of the bud has a concentration of points towards the bottom. [Figure 14](#) illustrates this step.

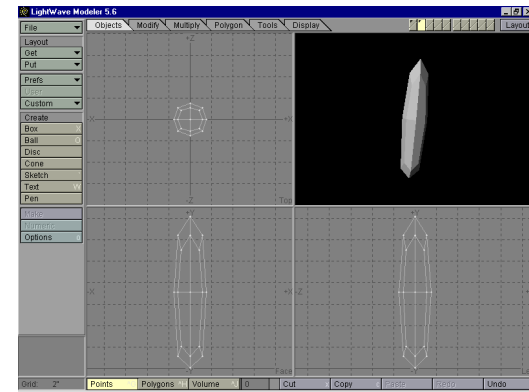


Figure 14: Squashing the points down along the Y axis.

14) Now Metaform the bud two more times and create a cylinder with 16 sides and 16 segments that's 500mm tall and slightly smaller in circumference than the stem we made before. Give it a bend of around 20° and line it up with the bottom of the bud so that it looks like a tail coming out of the bottom and align the bottom of the bud stem with the origin in all views, as in [Figure 15](#). Surface the bud as "Bud_Cyl_Y" and the stem as 'budstem_Cyl_Y' and save the whole thing as 'bud.lwo'. See? I told you it was easy.

That's about it as far as the modeling portion of this tutorial goes. If all went well, you should have five objects like those in [Figure 16](#).

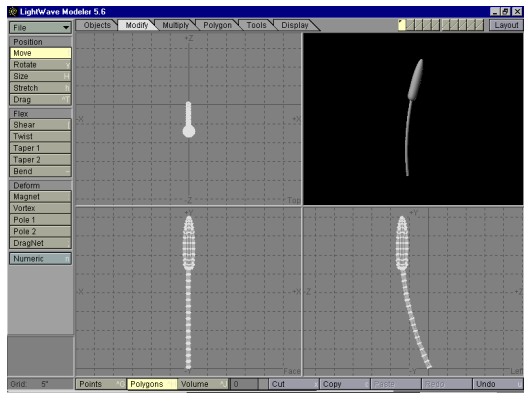


Figure 15: Bud with stem.



Figure 16: The five parts of the lily.

So now we have these five pieces of a lily. "What do we do with them?" you ask. Why, we texture them of course! Obviously, texturing is one of the most important aspects of creating a 3D image so be sure to take your time in this section.

The Texturing

Creating the Textures

15) We'll begin with the flower. Load the 'petal.lwo' into Modeler if it's not already there, and drag out the top view so that it encompasses the whole screen. Zoom in on the object now using the Fit All command. You should now be looking at a really big petal from the top. If you have screen capture software you can use it now, otherwise just hit the <Print Screen> key on your keyboard. This copies the current image on the screen to the clipboard.

16) Here is where we need Photoshop or any other image-editing program that has 'layers'. I'll be using version 4.0. Open up Photoshop and create a new document. The default size for the docu-

ment should be whatever your screen resolution is because that is the size of the image currently on the clipboard. Hit 'OK'. Now paste the image from the clipboard into the document. Using the crop tool, crop the document so that the petal fills the whole image. I find that using the Guides to outline the shape of the box before drawing the selection makes this process much easier. See [Figure 17](#) for a visual of this step.

- 17) Now we can have some fun. Create a second layer on top of the wireframe image. Set the transparency of the new layer to around 80%. This allows us to see through the layer that we're painting on so that we can use the wireframe as a guide without actually painting onto it. Depending upon your equipment, you could either use the Photoshop tools to create the image map, or you could actually scan in a petal of some sort and apply that to the image. It's up to you. I opted to paint my lily by hand with an orange hue. Create the petal texture and then save it as a PSD file. Do not flatten it.

Note that the Amiga IFF image loader/saver can be found in the Goodies\Plugins directory of the Photoshop 4.0 CD-ROM. Just copy the file 'aiff8b.8bi' into your Photoshop\Plugins\Formats directory on your hard drive.

- 18) Now, go back into Modeler, load up the 'flower.lwo' object, zoom in on it, take a screen shot, and paste it into a new Photoshop document. Crop it around the flower just like we did with the petal. Now, open the petal document and select the second layer that contains the petal image and copy it. Paste it into the new document on top of the wireframe flower. You can see in [Figure 18](#) that only the petal was pasted, not the background wireframe of the petal. That's why we didn't flatten the image earlier.

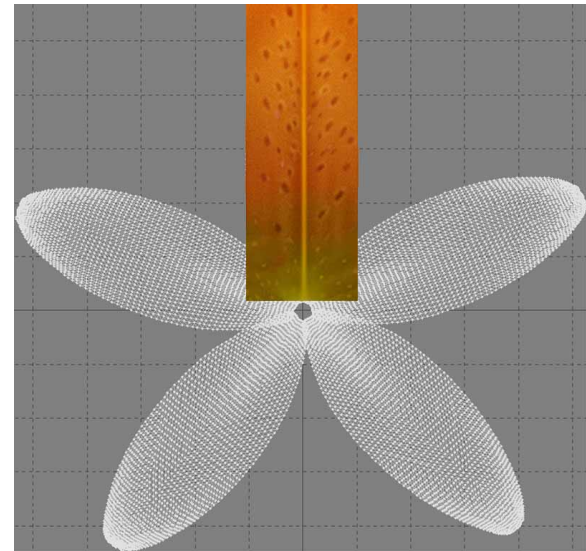
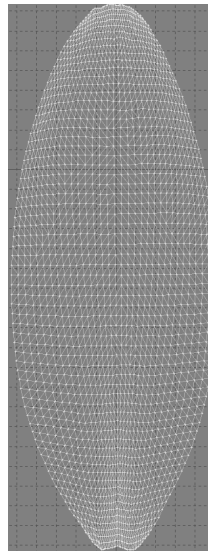


Figure 17: Cropping the screen capture of the flower (left).

Figure 18: Petal pasted into layered document (right).

The rest is simple. Just resize the new layer so that it fits one of the petals and line it up. Clone the layer four more times and use the Transform Layer tools to align each of the five layers with the petals. Make sure that all the layers are now set to 100% opacity and merge the petal layers together. The easiest way to do this is to link them together via the Layers window and then choose 'Merge Linked'. At this point, you might have to do some cloning and touching up here and there to get it just right. Copy the flower layer and paste it into a new, clean white document, flatten it, and save it as an IFF file. Phew... you'll be happy to know that the hardest part is behind us.

19) OK, now repeat steps 15-17 for the leaf, except this time at the end of step 17, copy the layer with the leaf texture on it and paste it into a new document, flatten it, and save it. **Figure 20** shows you what I came up with.

20) Now for the bud. This is a little trickier to do

only because we're creating a cylindrical map rather than a planar map. The first two steps are the same as for the two planar maps that we just created. Get a screen capture of the bud in the face view and crop the document to fit it. Be sure that you crop the image around only the bud, not the stem. Here is where it changes. Paint the side of the bud just as you would paint the leaf or the petal. Once you're finished, copy it to the clipboard and click on 'New' to open up a new document. Once again, the default size of the document should automatically be whatever the size of the image on the clipboard is. Leave the height the



Figure 19: The final petal texture (left). Figure 20: The leaf Texture (middle). Figure 21 Bud texture (right).

way it is, but double the width. Create the new document and paste the image into it. Align the image with one side of the document. You can see that because we doubled the width, there is room for another copy of the image. Duplicate the layer or simply paste the image into the document again and flip this new layer horizontally and line it up with the other side of the document. What you should end up with is two identical images mirrored next to one another (Figure 21). Now flatten the image and if there is a visible seam in the middle where the two layers were connected, paint it out with the clone tool.

We should now have three textures: the petal texture, the leaf texture, and the bud texture. We'll be able to use these for the color textures as well as the bump maps. Well, we're finally ready put it all together in Layout, so let's go!

Applying the Textures

20) Once you have Layout open, load in the six parts of the flower. Don't worry if they are overlapping on another. That will be changed when we position them later on.

- petal.lwo
- leaf.lwo

- bud.lwo
- stembig.lwo
- stemsmall.lwo

21) Now load in the three image maps that we just created. We'll texture the petal first. Apply the petal's image map to the 'Petal_P_Y' surface as a planar map on the 'Y' axis, just as the surface name indicates. Choose 'Automatic Sizing' and turn off 'Texture Anti-aliasing'. Apply the same image as a planar bump map on the 'Y' axis with the same options. Give the bump map an amplitude of about 100%. As far as the rest of the settings go, I chose what I thought looked best, however you can certainly adjust the surface attributes to your liking. Although these settings are somewhat optional, keep in mind the fact that most plants and even petals have some sort of specularity to their surface, which you should be sure to include on your flowers.

- Luminosity = 0.0%
- Diffuse Level = 80%
- Specular Level = 15%
- Color Highlights = Checked
- Glossiness = Medium
- Reflectivity = 0%
- Transparency = 0%

22) We'll do the same for the leaf. Apply its texture maps in the same manner. The only settings that I changed are the other surfacing attributes.

Luminosity = 0.0%
Diffuse Level = 90%
Specular Level = 15%
Color Highlights = UnChecked
Glossiness = Medium
Reflectivity = 0%
Transparency = 0%

23) For the bud, just apply its image map as a cylindrical map on the 'Y' axis. Select 'Auto-sizing', turn off texture anti-aliasing, and if you like, apply it as a bump map as well. The rest of the surface settings for the bud are identical to those of the petal.

24) The three stem surfaces ('Budstem_Cyl_Y', 'Stembig_Cyl_Y', and 'Stemsmall_Cyl_Y') can all be surfaced with the leaf color texture. Simply apply it as a cylindrical map along the 'Y' axis. You can also use the leaf's surfacing attributes for the stems. Easy, eh?

25) OK, last but certainly not least is the stamen. The 'stamen' surface was easy...

Surface Color = 240,150,40
Luminosity = 0.0%
Diffuse Level = 90%
Specular Level = 25%
Color Highlights = Checked
Glossiness = Medium
Reflectivity = 0%
Transparency = 0%

...and the 'pollenbud' surface wasn't much harder.

Surface Color = 70,55,30
Luminosity = 0.0%
Diffuse Level = 70%
Specular Level = 10%
Color Highlights = Un-Checked
Glossiness = Medium
Reflectivity = 0%
Transparency = 0%

Well, that's about it for the texturing. The last step in the whole process is simply to assemble the lily and set up some lights.

The Assembly

- 26) So now we have all of the objects modeled and textured but we still don't have anything that resembles a lily. No problem, that's about to change. First, parent all of the objects to the main stem ('stembig.lwo'.) Create a Null object and name it 'Lily Parent Null'. Now parent the main stem to the null. What we have just done is given ourselves the ability to adjust the position of the entire lily through one object.
- 27) We are now able to arrange the objects that comprise the lily into what we feel best matches our reference image or our imagination. Also, by having modeled the 'stemsmall.lwo' object, we can clone this around the plant in various places so that we can attach some more flowers. Have fun! This is where all the work that we have done pays off!
- 28) Once you have assembled the lily to your liking, save the scene as something like 'lilyloader.lws'. Guess what, that's it! Now, anytime you wish to use the lilies in a scene, simply go to the Objects panel and choose 'Load From Scene', choose 'lilyloader.lws' and all the objects will be loaded into your current scene. Their hier-

archies will be intact and their texture maps perfectly aligned, just the way you left them. You may even want to set up a few scenes, each with slightly different versions of the plant to avoid obvious repetition.

This is a very useful technique for getting around the lack of UV Mapping support in LightWave as it allows you to align the textures properly while still being able to replicate a group of objects as many times as is necessary. This technique can be applied to any type of object that requires similar control over the texturing and positioning.



Figure 22: Final image.

Closing Up

The final product that I ended up with after this tutorial is what you see in [Figure 22](#). Of course, yours will probably look substantially different due to the variation in texture maps. If you found that you had trouble creating the texture maps, they can be downloaded from the “Support Files” link above the Mastering 3D Graphics website.

The technique described in this tutorial can be used as a basis for the creation of an entire scene, as shown by the work-in-progress in [Figure 23](#). Once you get the hang of it, you’ll find that it works wonders for digital botany no matter how great the task.

Although greenery does add a lot to an image, be careful not to rely on it to make your image look good. Always keep in mind that proper lighting, modeling, texturing, and composition all come together to form the final image. Hopefully this tutorial showed you that beautiful and intricate flowers and plants can be created with relative ease. The realism that they add to your images is certainly well worth the effort it takes to create them.

Chris MacDonald is a freelance artist and a junior in high school living in Fredericksburg, VA. He is currently working in conjunction with Team Komodo and Komodo Comics on the new 3D comic book, Platinum. Chris is an avid Lightwave user specializing in environmental photorealism such as botany, terrain, and man-made structures. He can be reached at busha@aol.com.



Figure 23: Another example of digital botany.





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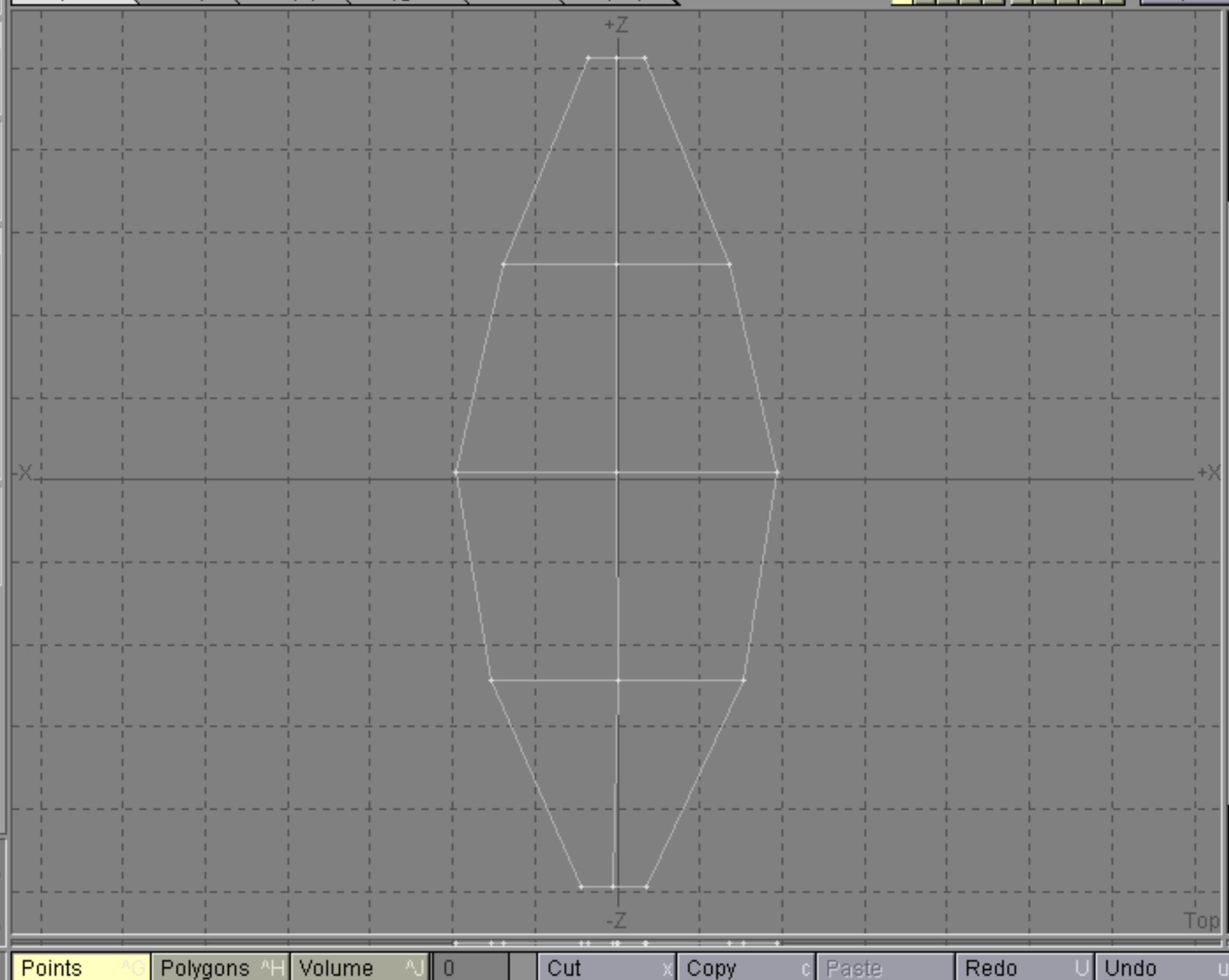
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Z: -4'1.82"

Grid: 10"



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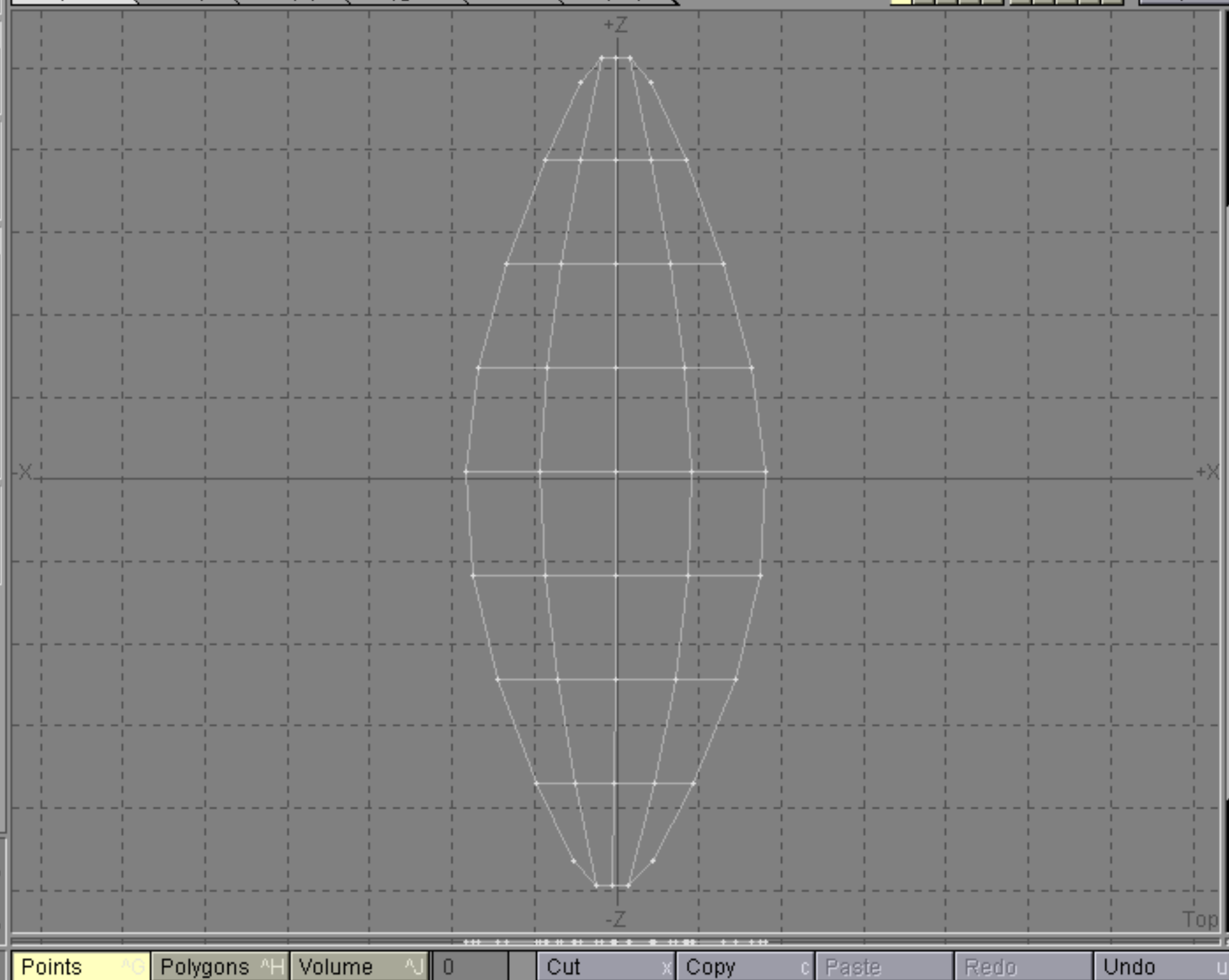
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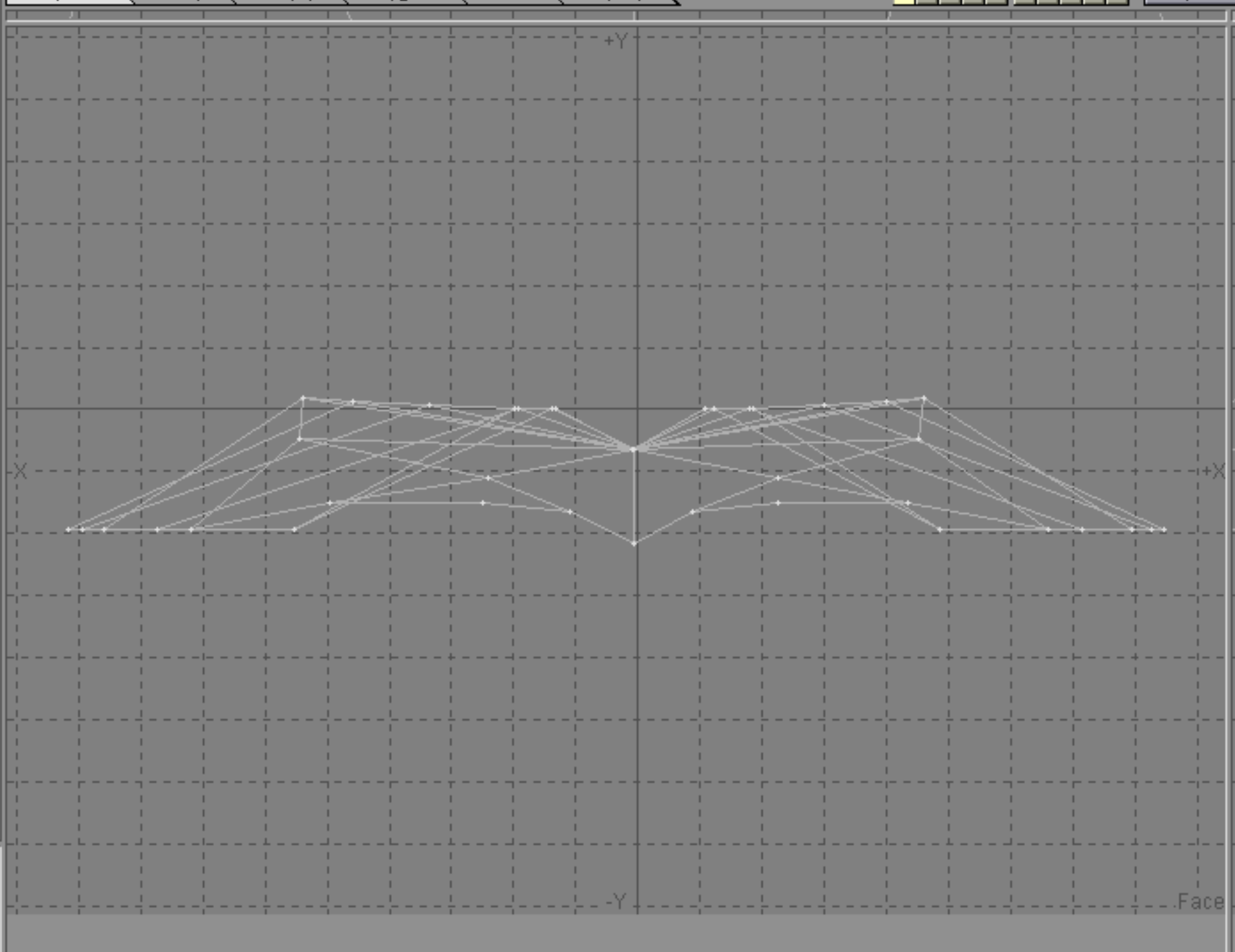
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Sketch

Text W

Pen

Make

Numeric

Options O

Objects

Modify

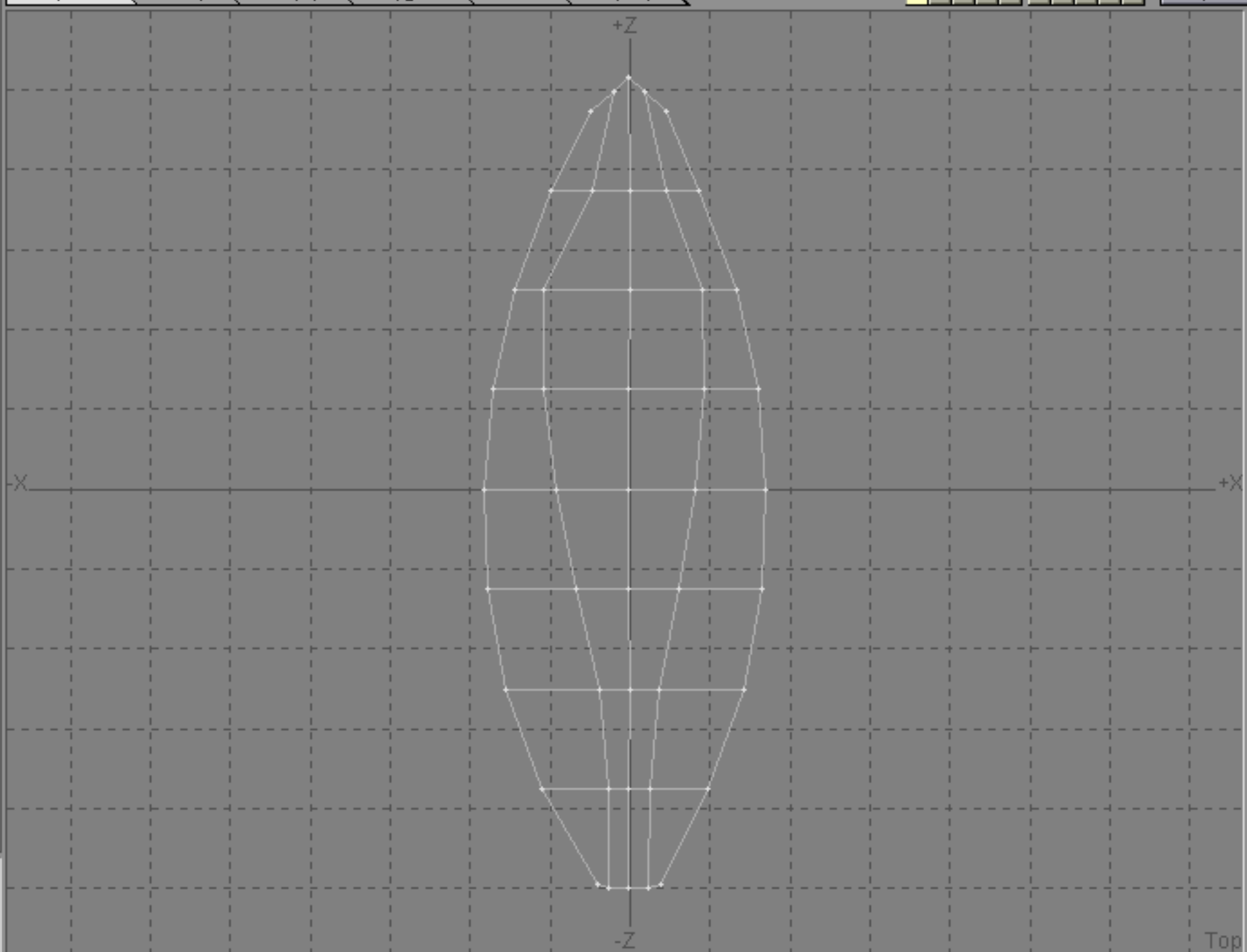
Multiply

Polygon

Tools

Display

Layout



File ▾

Position

Move

Rotate γ

Size H

Stretch h

Drag $\wedge T$

Flex

Shear [

Twist

Taper 1

Taper 2

Bend ~

Deform

Magnet

Vortex

Pole 1

Pole 2

DragNet

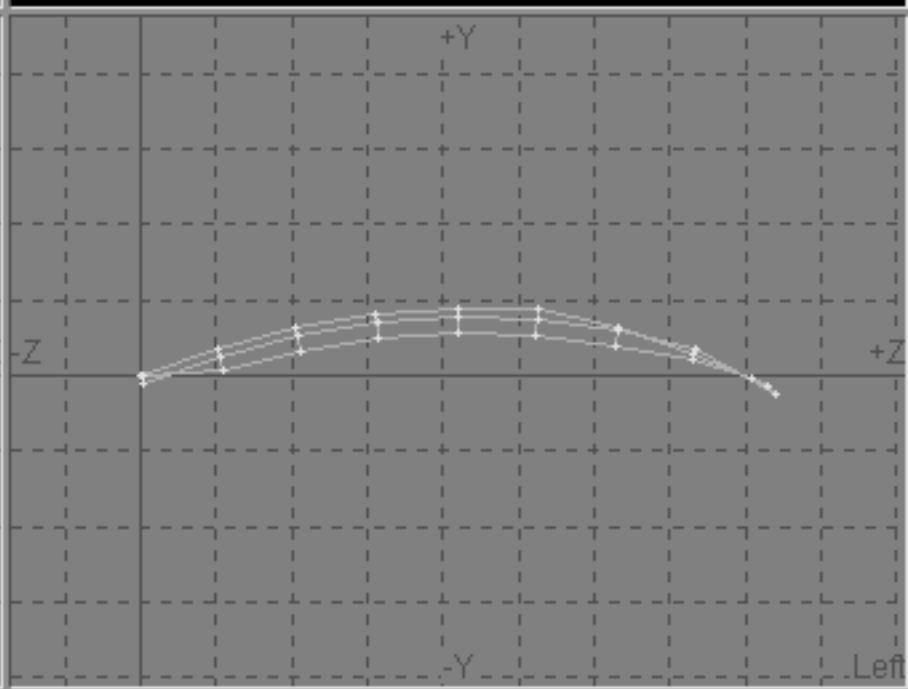
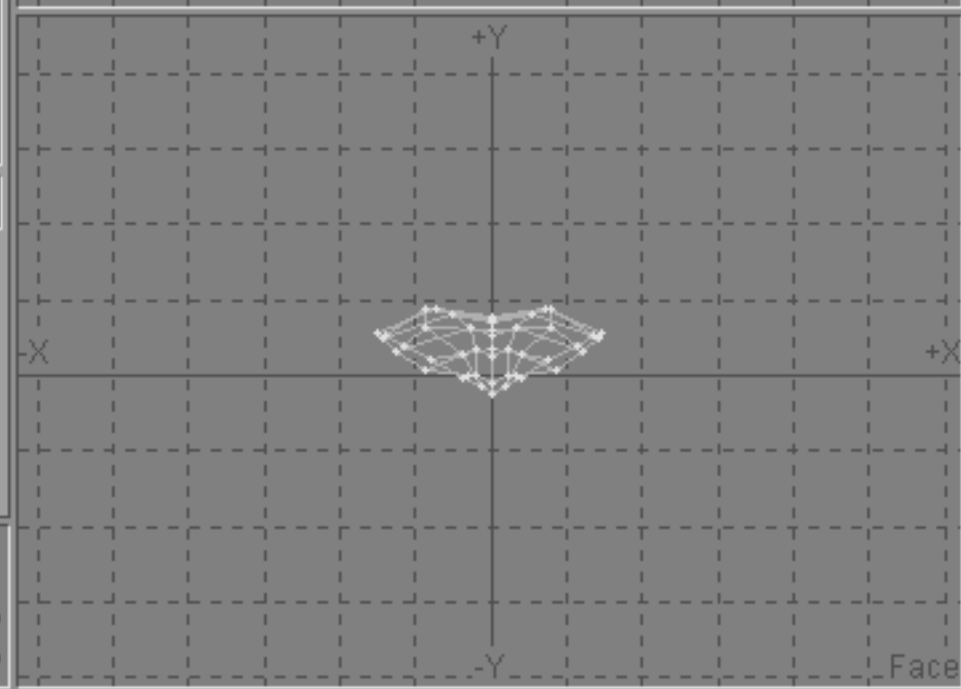
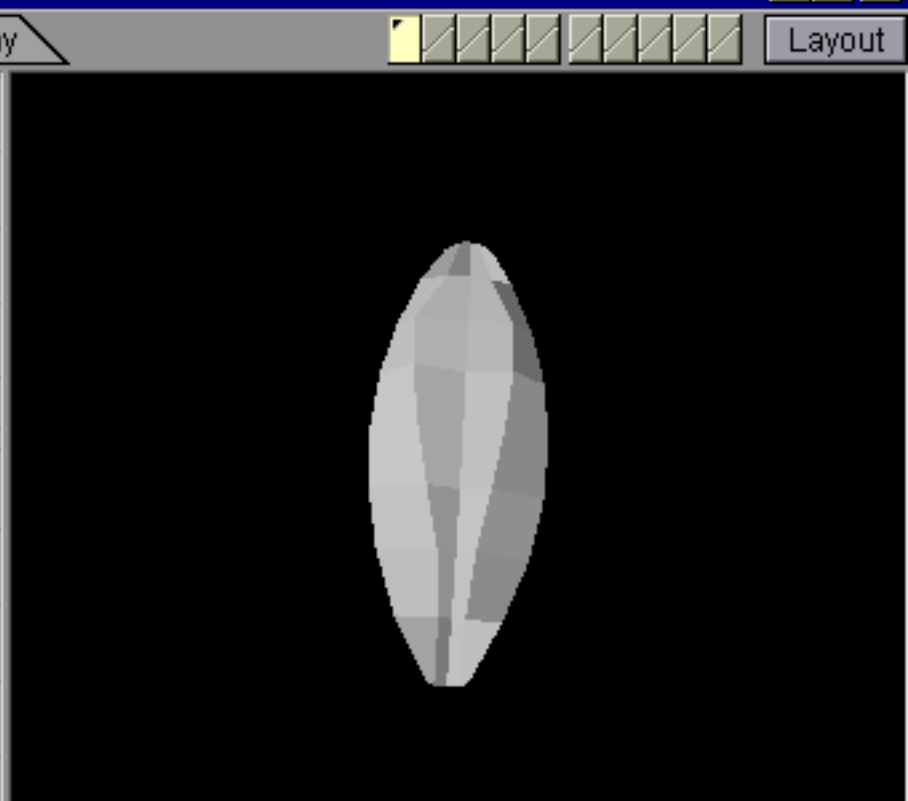
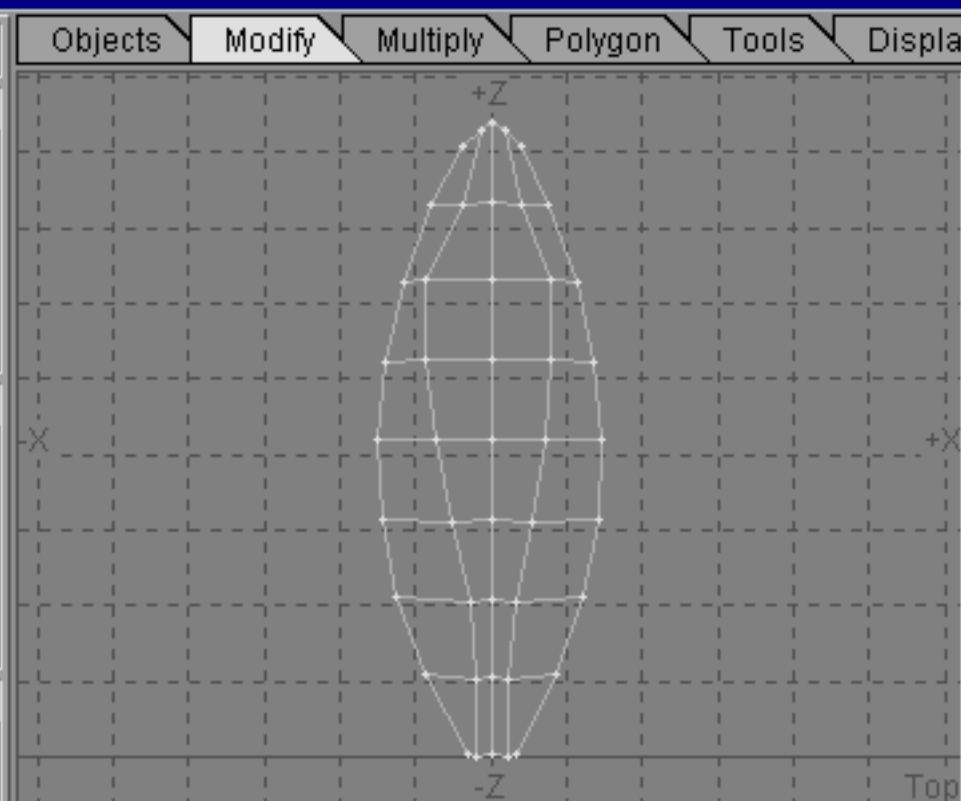
Numeric n

Position

X:

Y: -9.3095"

Z: 17.863"



File

Objects

Modify

Multiply

Polygon

Tools

Display



Layout

Position

Move

Rotate

Size

Stretch

Drag

Flex

Shear

Twist

Taper 1

Taper 2

Bend

Deform

Magnet

Vortex

Pole 1

Pole 2

DragNet

Numeric

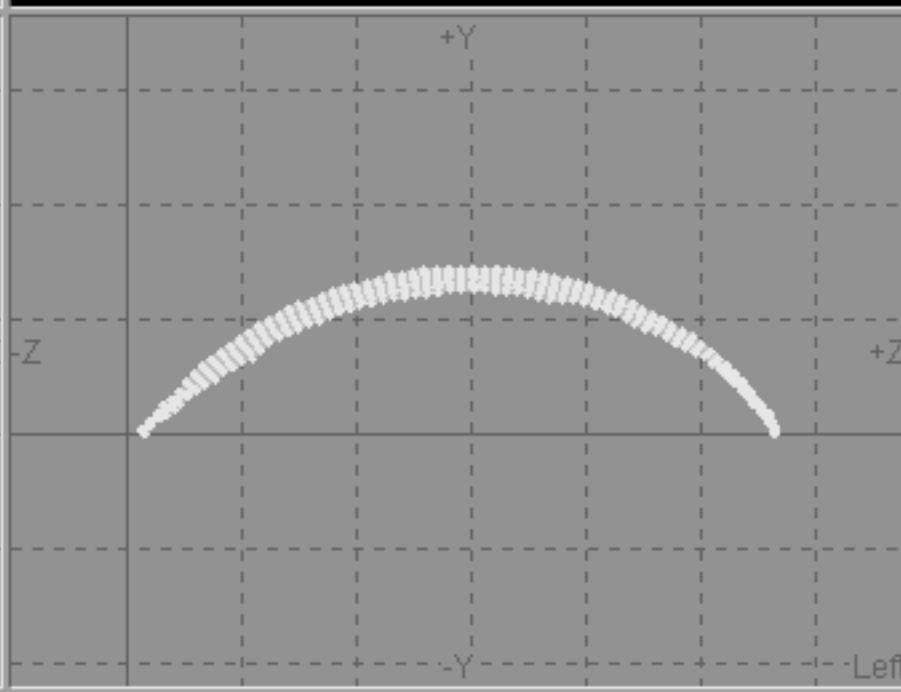
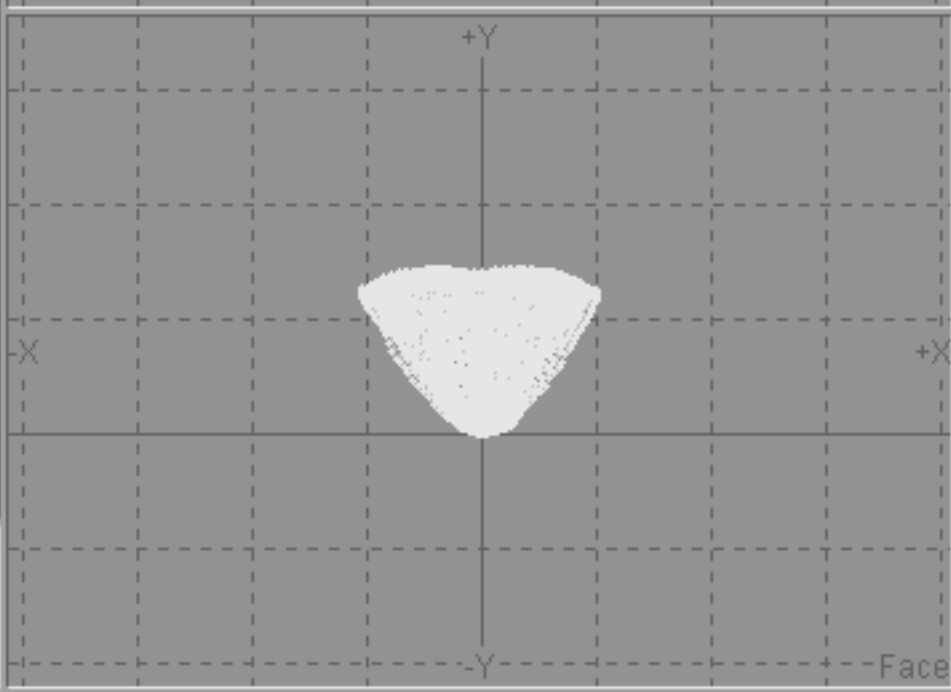
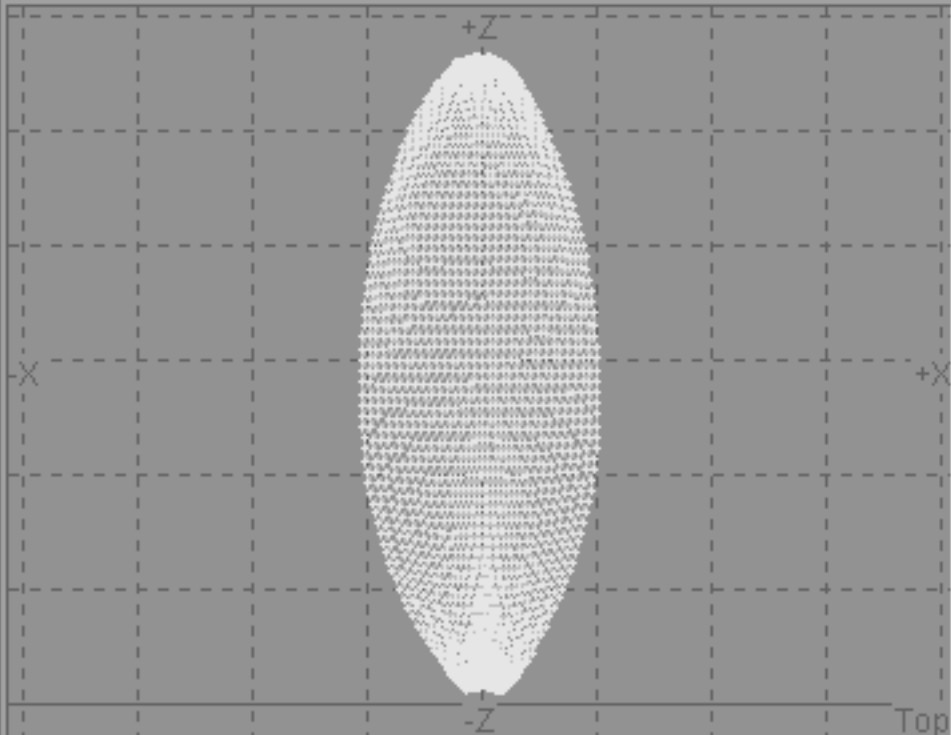
Position

X: 1'6.209"

Y: -8.6035"

Z:

Grid: 5"



Points ^G

Polygons ^H

Volume ^J

0

Cut

x

Copy

c

Paste

Redo

Undo

u

File

Objects

Modify

Multiply

Polygon

Tools

Display

Layout

Position

Move

Rotate

Size

Stretch

Drag

Flex

Shear

Twist

Taper 1

Taper 2

Bend

Deform

Magnet

Vortex

Pole 1

Pole 2

DragNet

Numeric

Position

X: -1'7.38"

Y: -1'4.73"

Z:

Grid: 10"

Points

Polygons

Volume

0

Cut

x

Copy

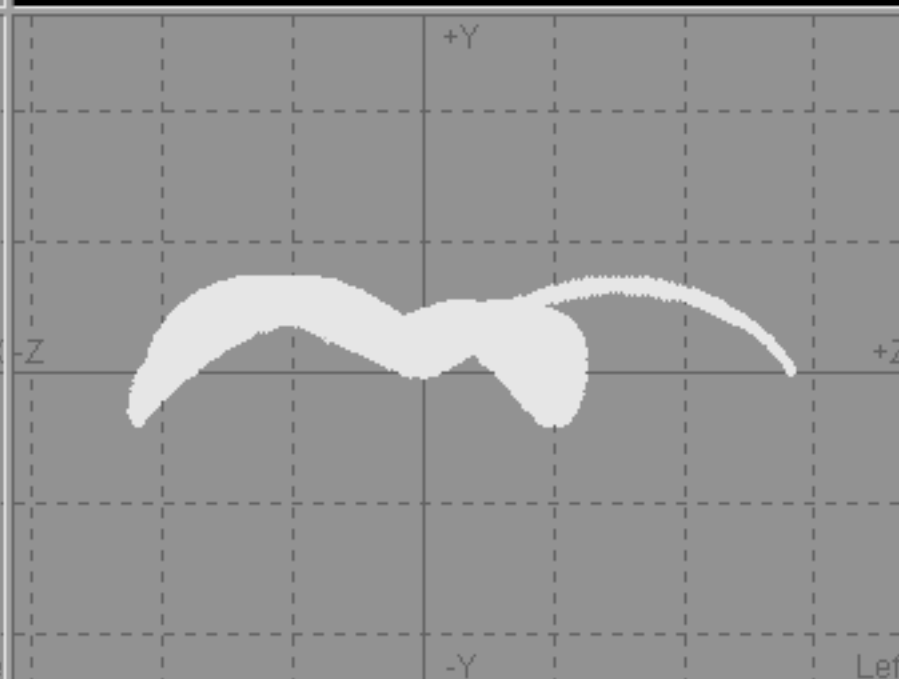
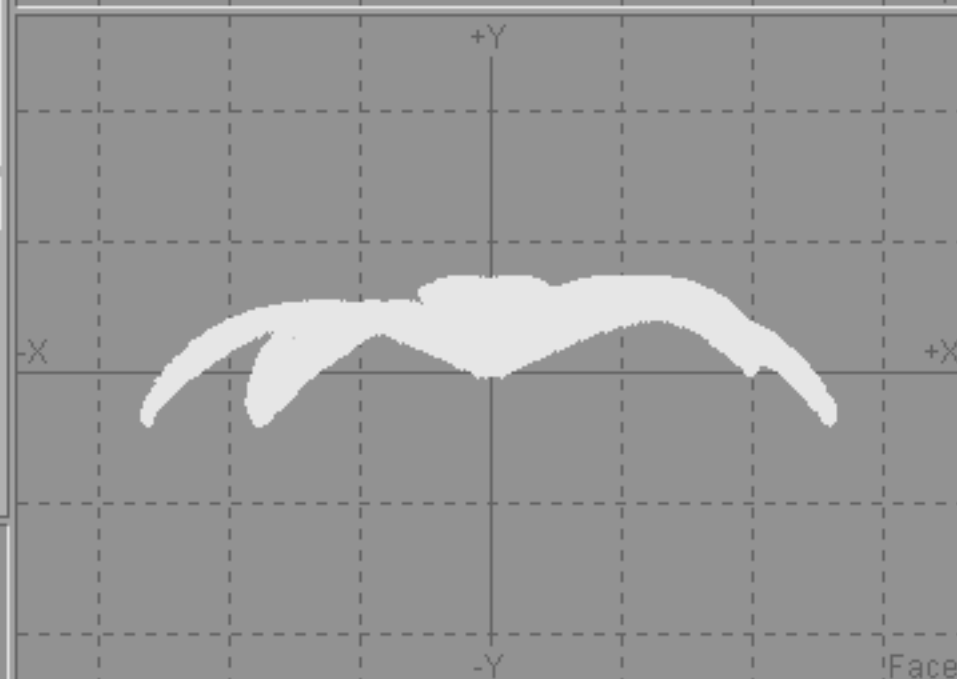
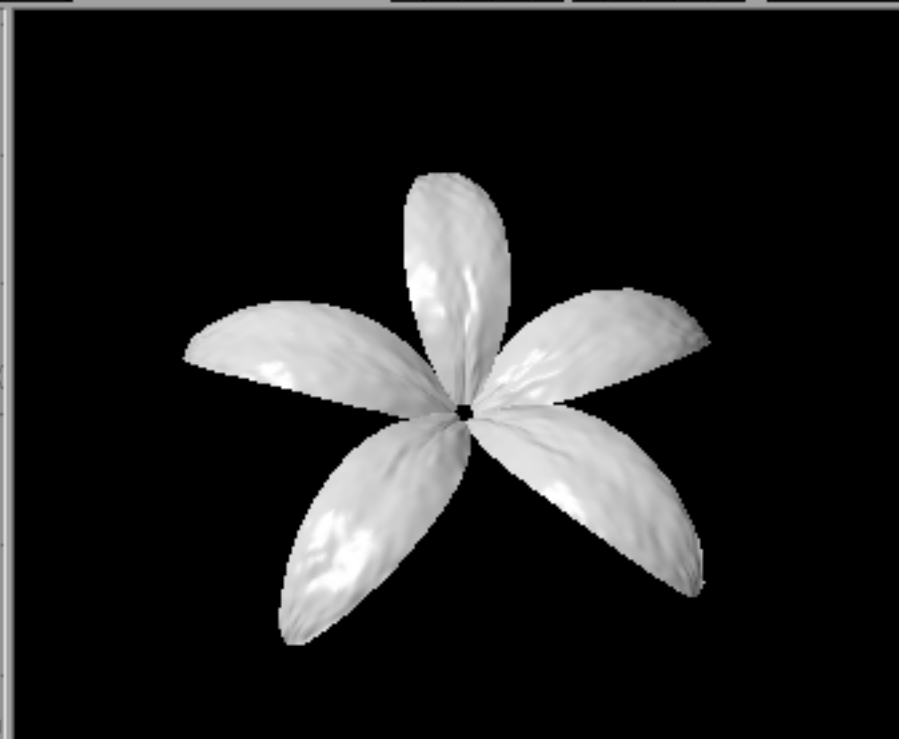
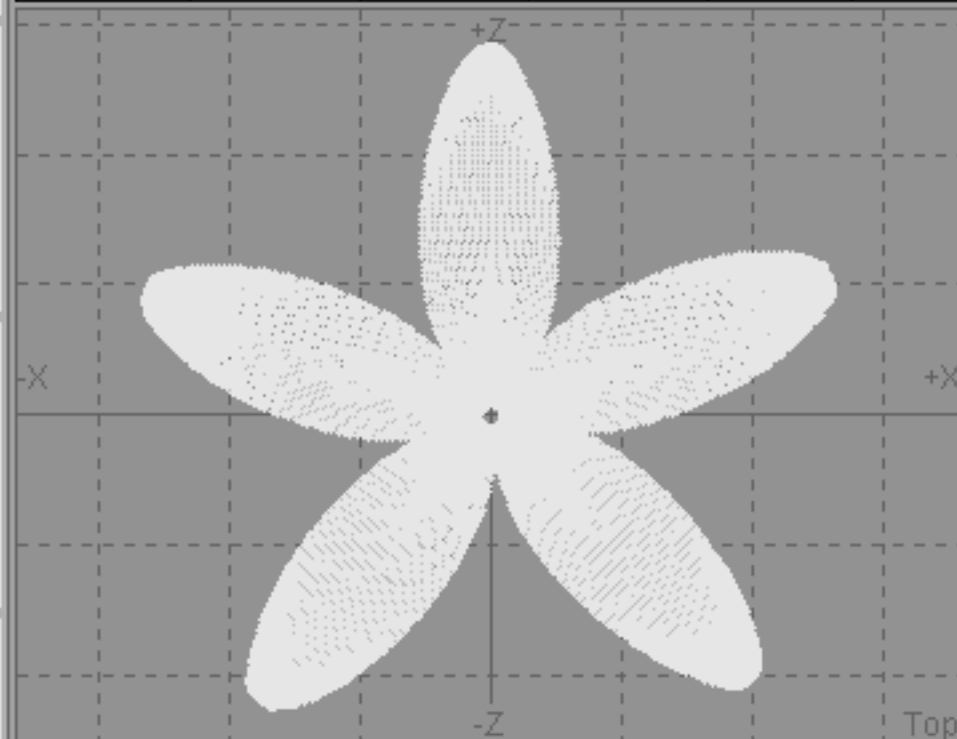
c

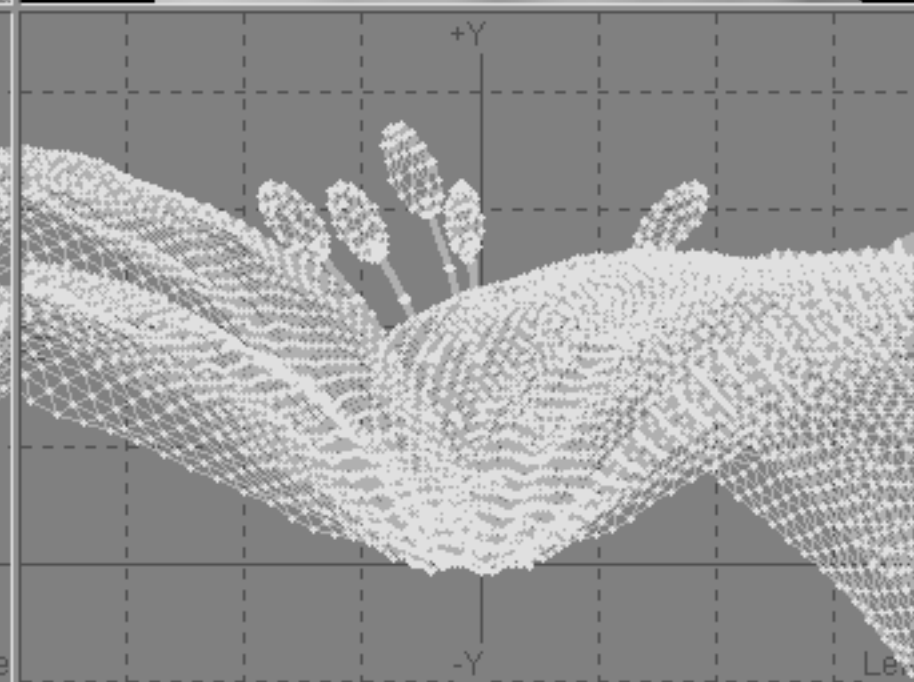
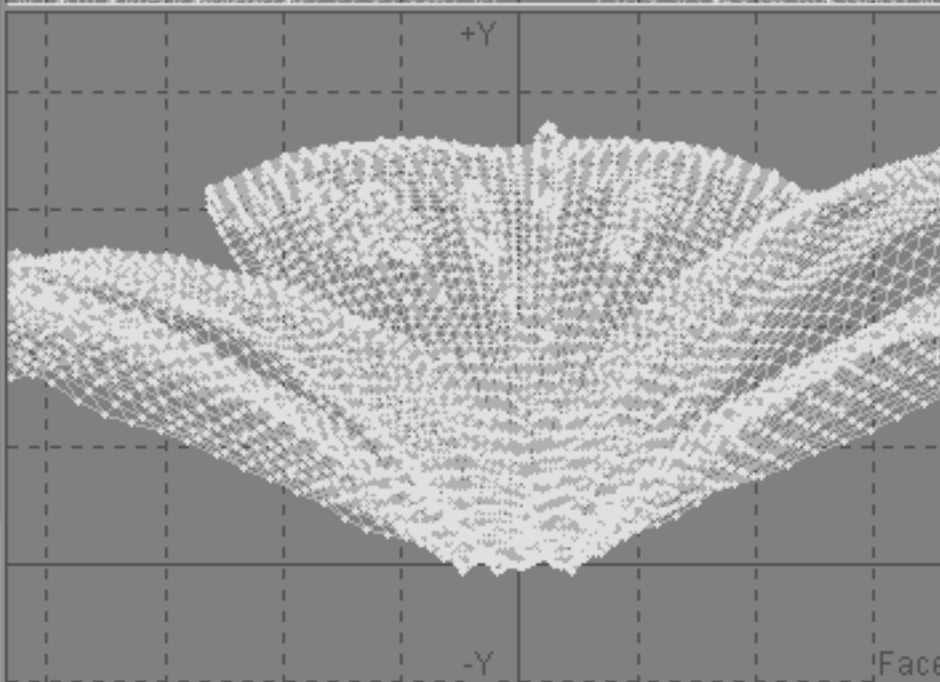
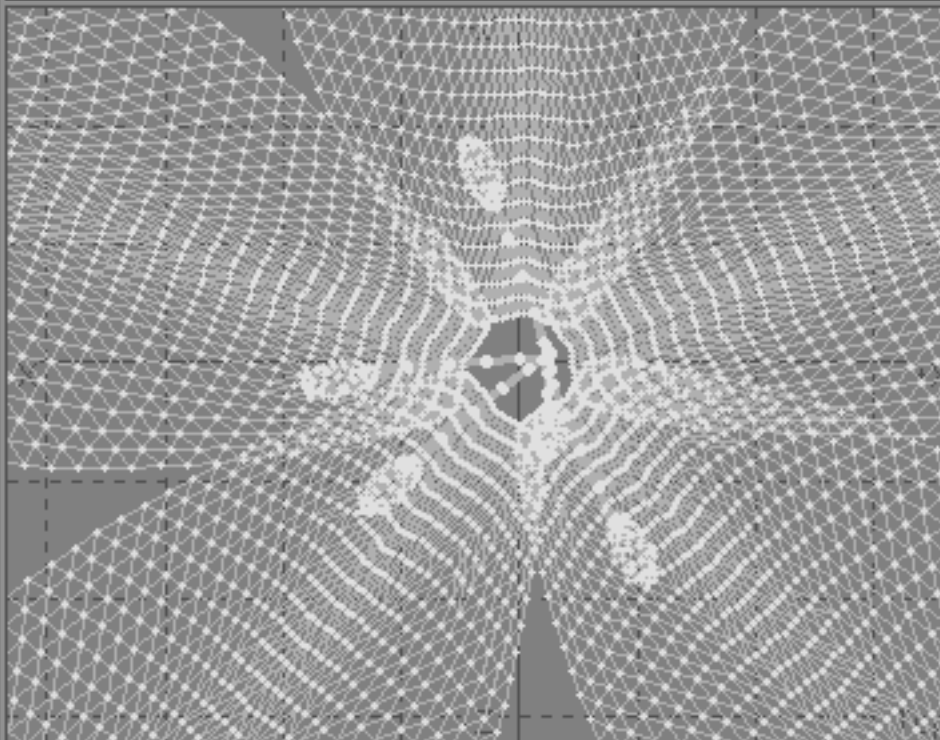
Paste

Redo

Undo

u





File ▾

Position

Move

Rotate γ

Size H

Stretch h

Drag $\wedge T$

Flex

Shear [

Twist

Taper 1

Taper 2

Bend ~

Deform

Magnet :

Vortex

Pole 1

Pole 2

DragNet :

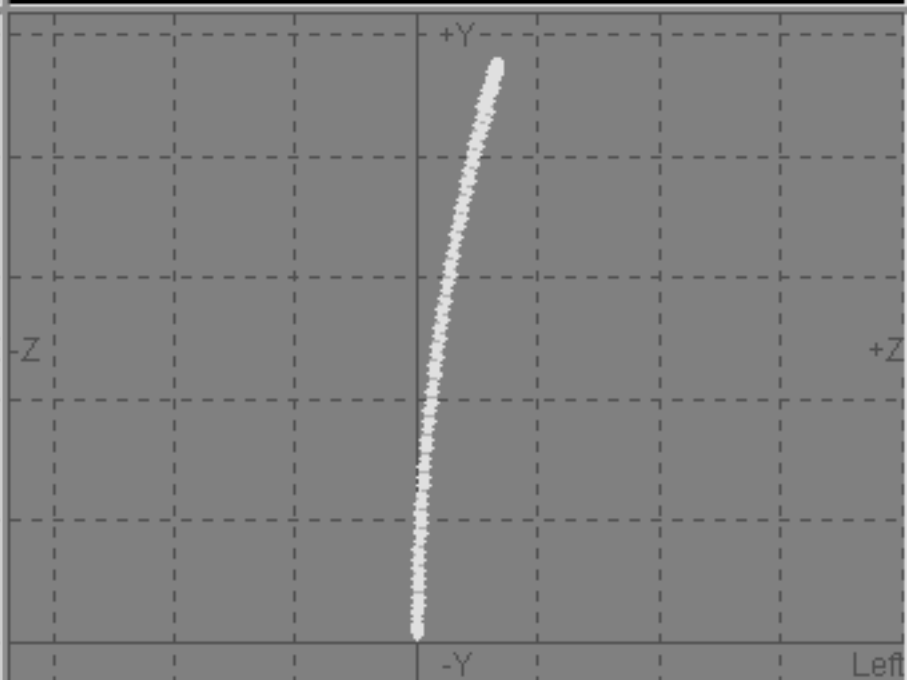
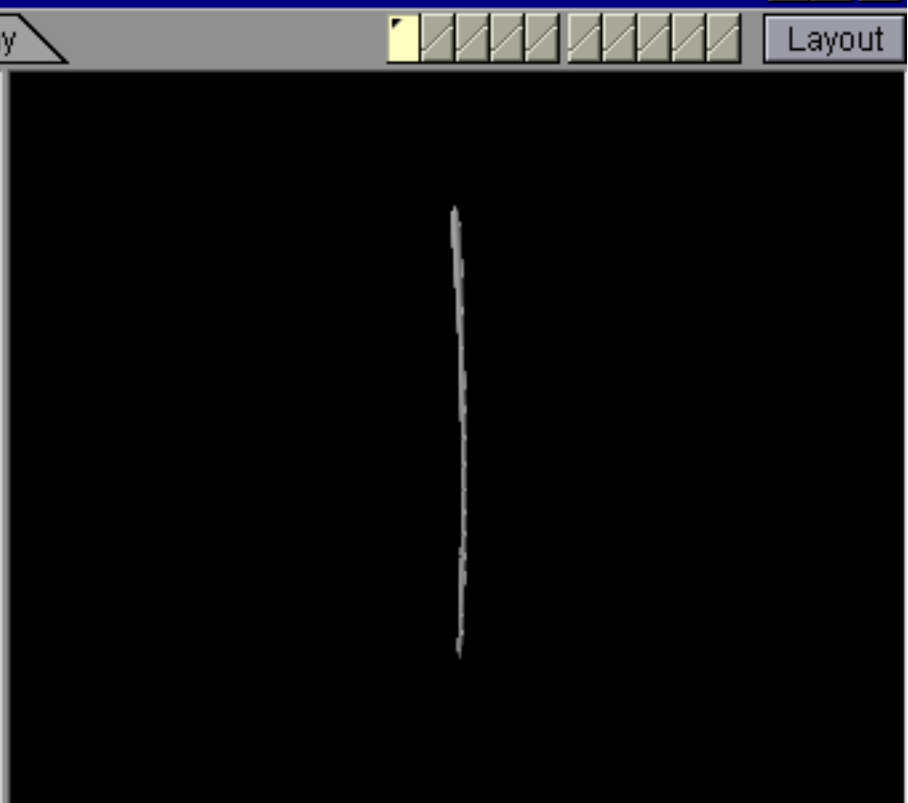
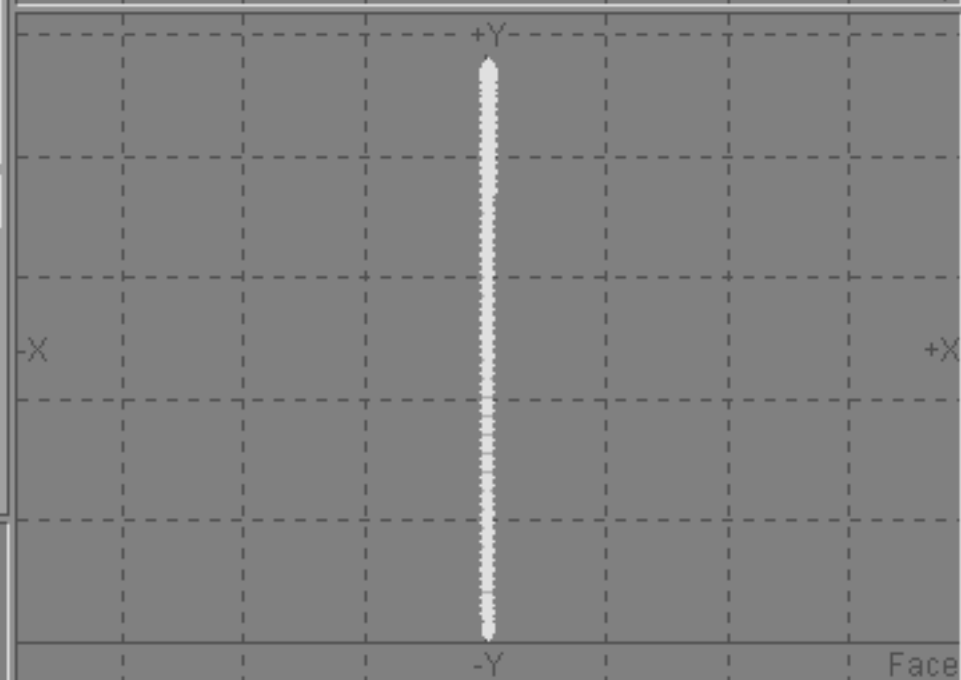
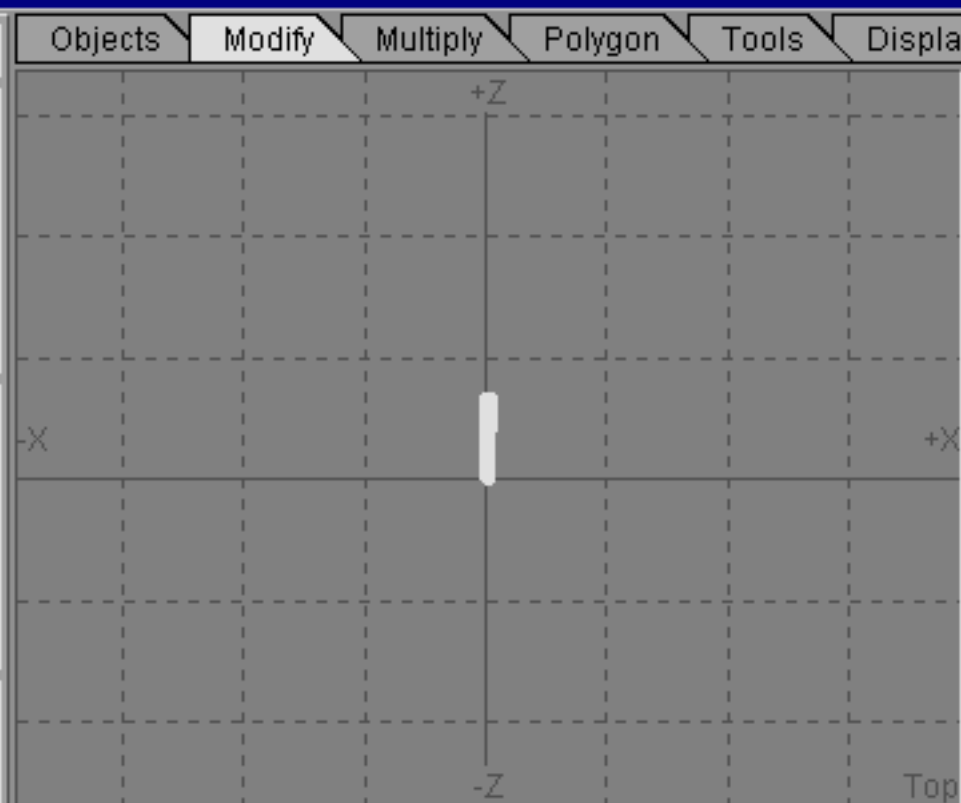
Numeric n

Position

X:

Y: 8'7.793"

Z: 1'2.854"



Grid: 2'

Points $\wedge G$ Polygons $\wedge H$ Volume $\wedge J$ 0 Cut x Copy c Paste Redo Undo u

File

Position

Move t

Rotate y

Size H

Stretch h

Drag AT

Flex

Shear [

Twist

Taper 1

Taper 2

Bend ~

Deform

Magnet

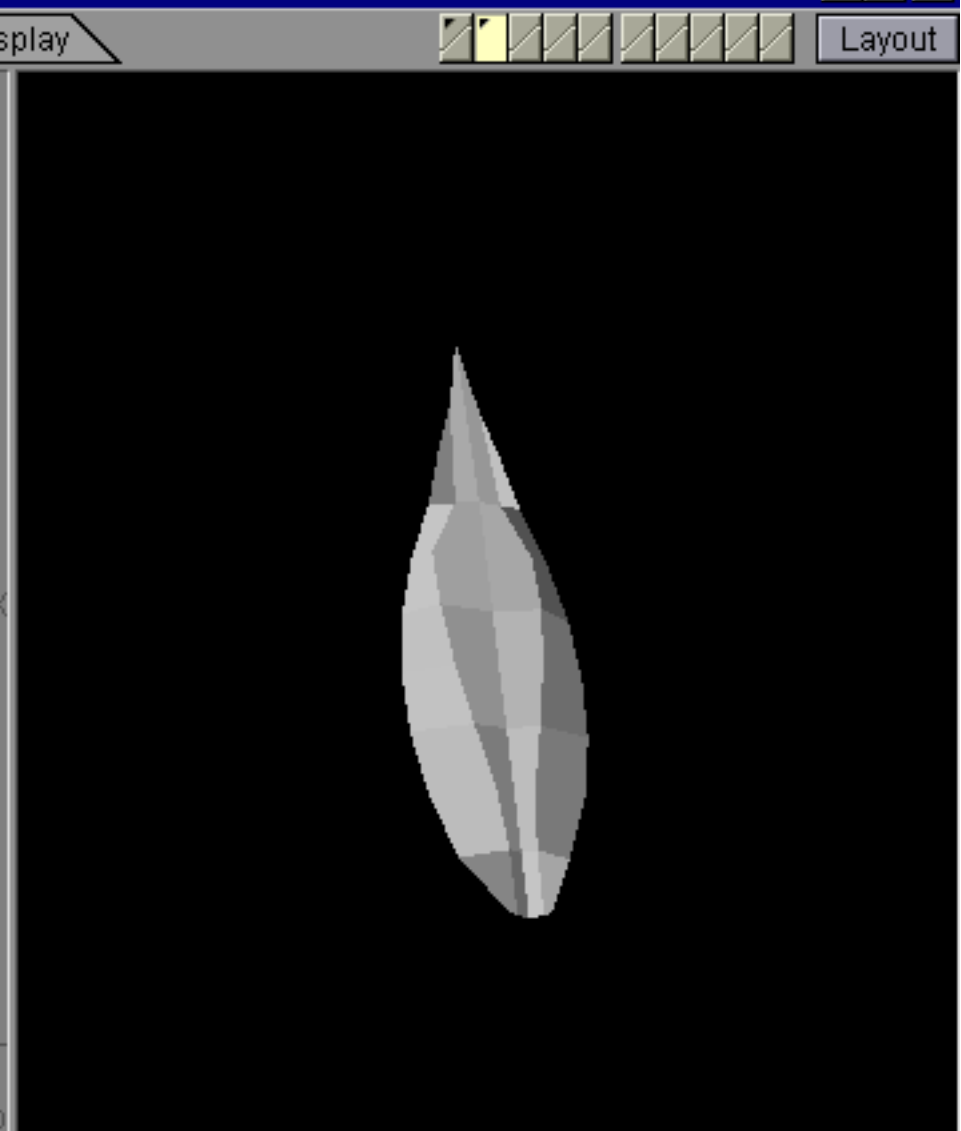
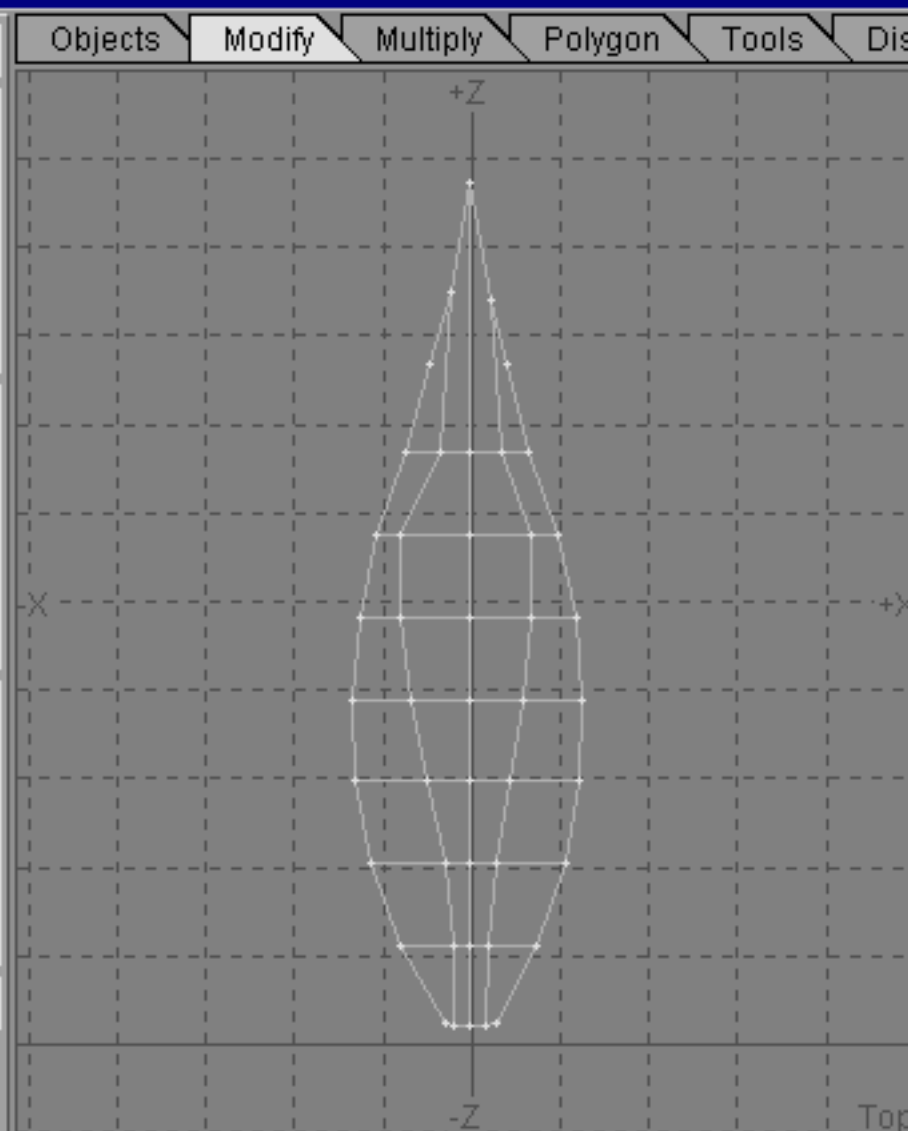
Vortex

Pole 1

Pole 2

DragNet

Numeric n

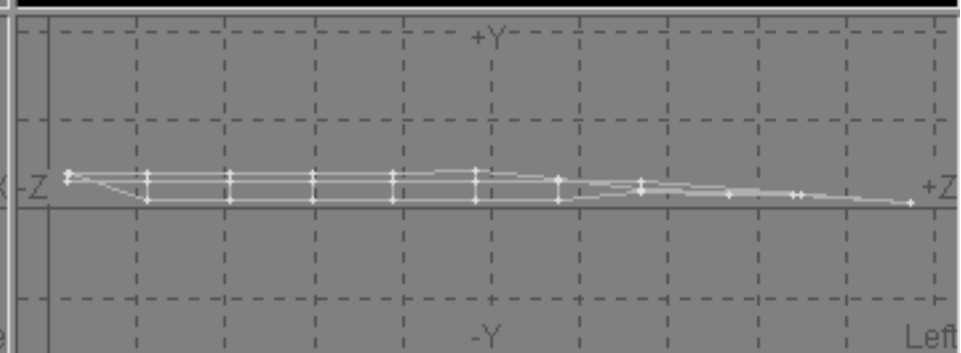
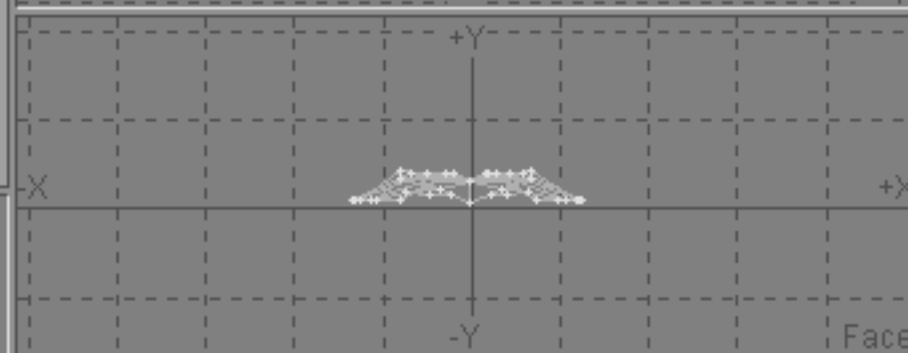


Position

X:

Y: -2.0529"

Z: 1'8.482"



Grid: 5"

Points ^G Polygons ^H Volume ^J 0 Cut x Copy c Paste Redo Undo u

File ▾

Position

Move t

Rotate y

Size H

Stretch h

Drag AT

Flex

Shear [

Twist

Taper 1

Taper 2

Bend ~

Deform

Magnet :

Vortex

Pole 1

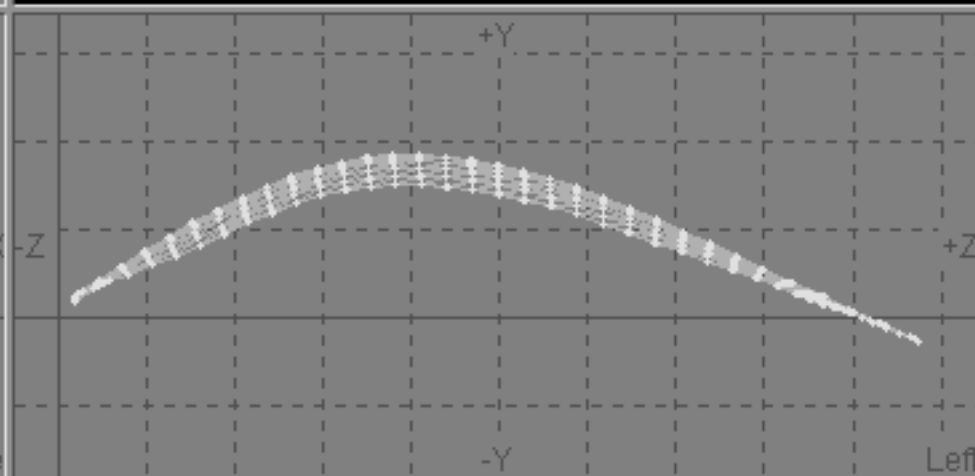
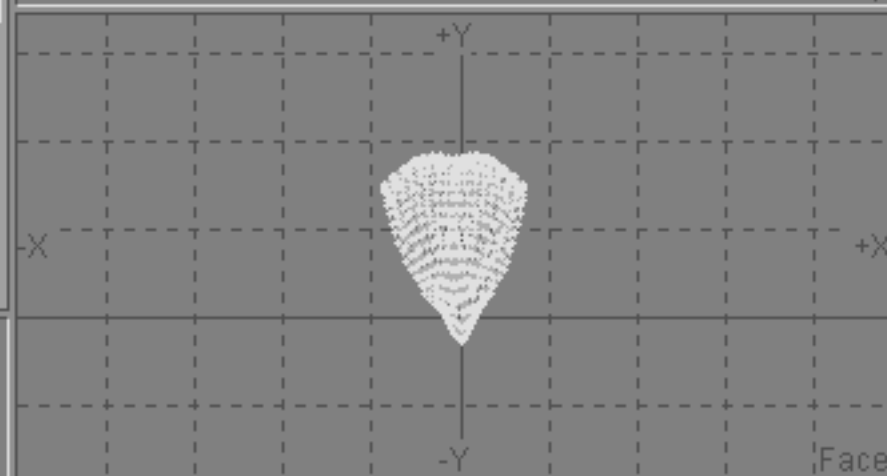
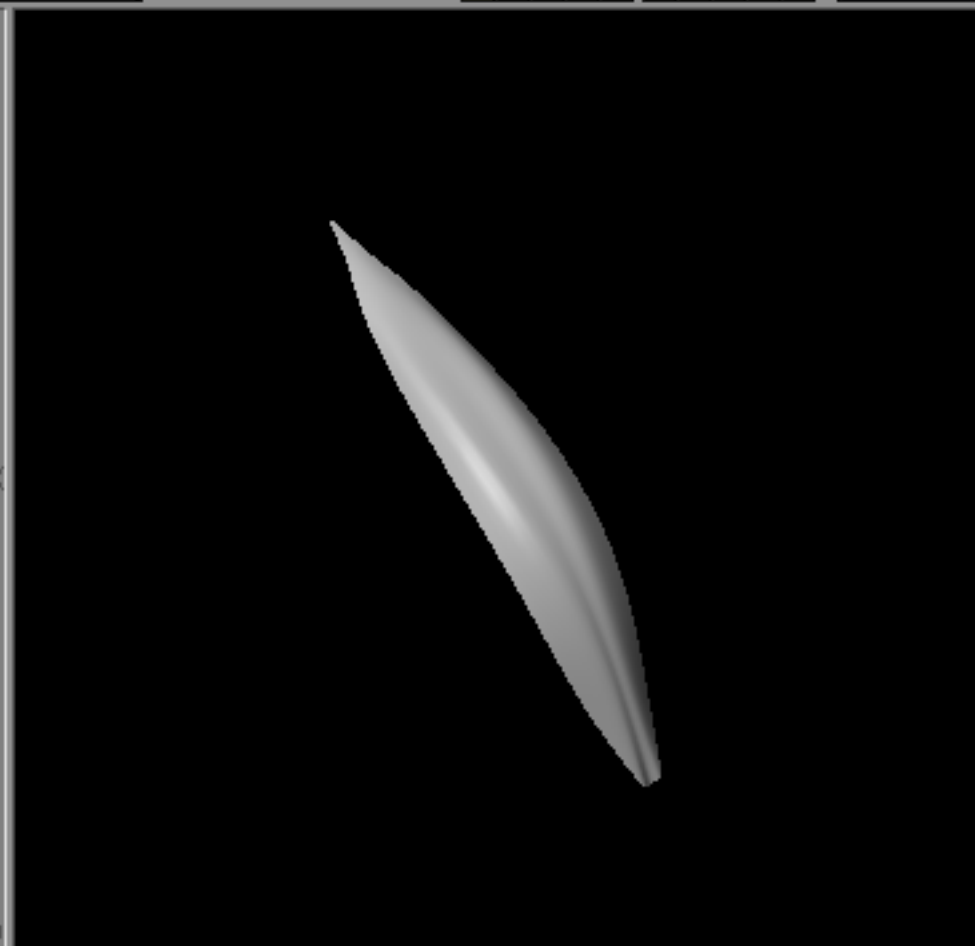
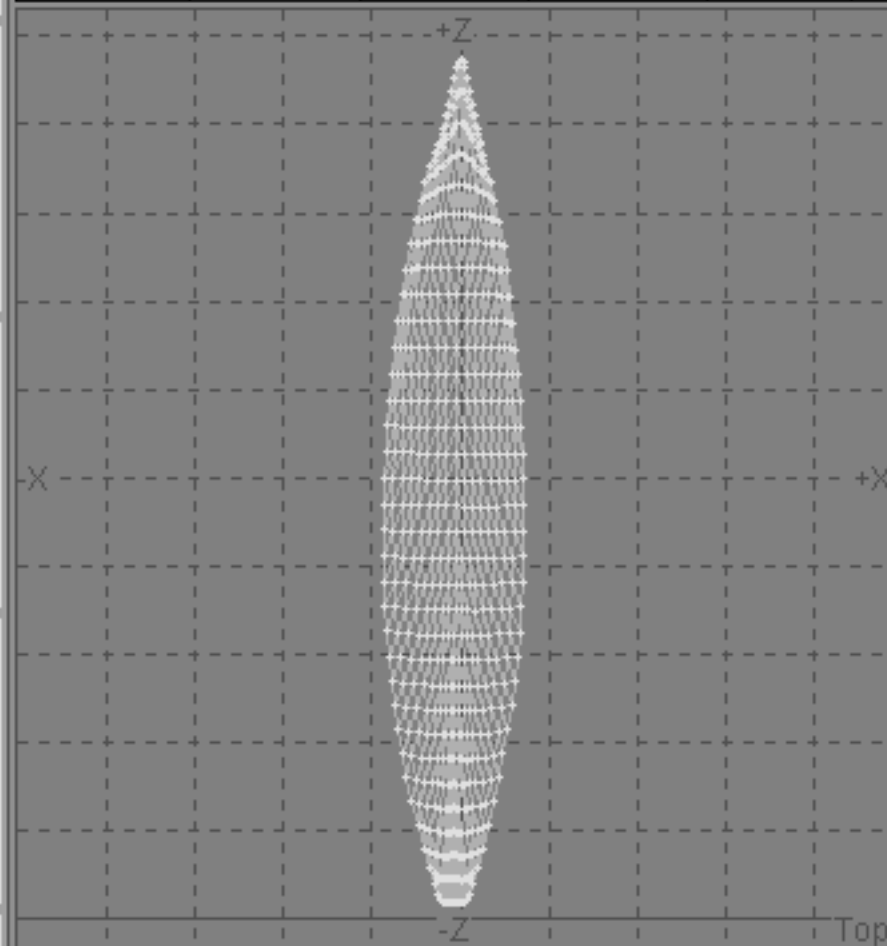
Pole 2

DragNet :

Numeric n

Objects Modify Multiply Polygon Tools Display

Layout



Position

X:

Y: -8.33"

Z: 1'2.711"

Grid: 5"

Points AG Polygons AH Volume AJ 0 Cut x Copy c Paste Redo Undo u

File ▾

Layout

Get ▾

Put ▾

Prefs ▾

User

Custom ▾

Create

Box X

Ball O

Disc

Cone

Sketch

Text W

Pen

Make

Numeric

Options 0

Objects Modify Multiply Polygon Tools Display

+Z

+X

-Z

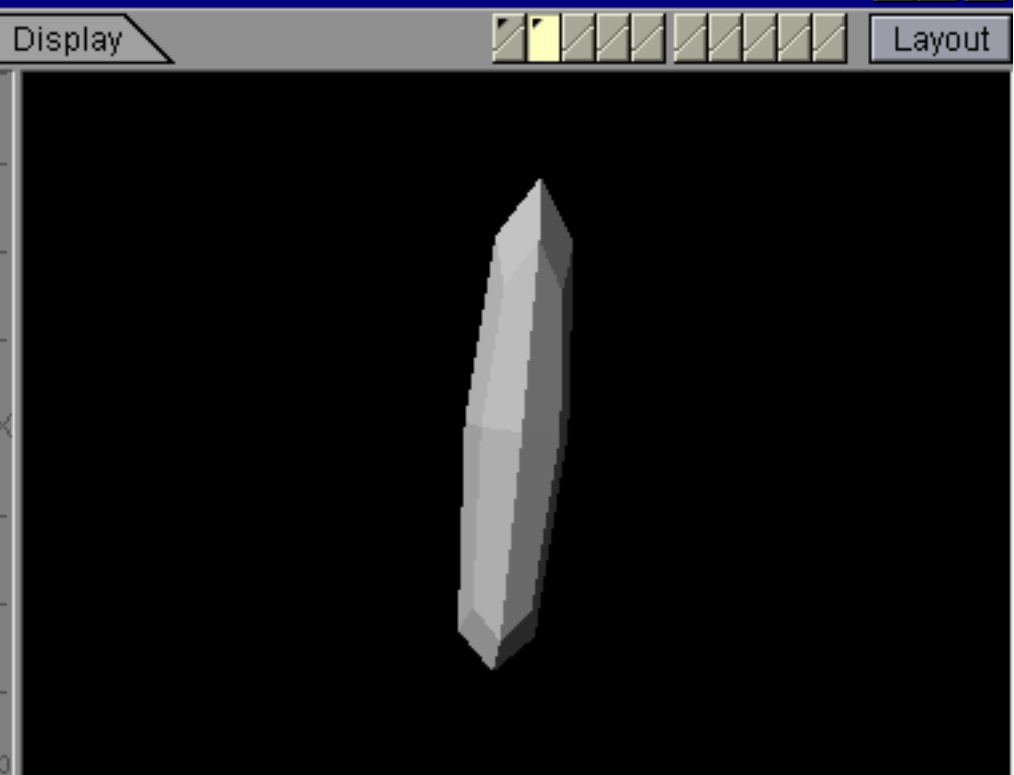
Top

+Y

+X

-Y

Face



+Y

+Z

-Y

Left

- File
- Position
- Move
- Rotate
- Size
- Stretch
- Drag
- Flex
- Shear
- Twist
- Taper 1
- Taper 2
- Bend
- Deform
- Magnet
- Vortex
- Pole 1
- Pole 2
- DragNet
- Numeric

Objects Modify Multiply Polygon Tools Display

Layout

