# Lesson 07
# Polygonal modeling

In this lesson, you will create Boog, the bear from the Sony Pictures Animation Inc. movie *Open Season*. The character will be created starting from primitives. You will use many polygonal tools and deformers until the desired shape is achieved. As you learned in the first project, it will be possible to edit the construction history of modeling actions to update the model as you go. As well, you can edit the results throughout the lesson until you delete the history.

### In this lesson you will learn the following:

- How to model starting from a cube primitive;
- How to model using polygon proxy;
- How to mirror geometry;
- How to work with polygonal components;
- How to edit the topology of a polygonal model;
- How to work with procedural modeling attributes;
- How to change edge normals;
- How to use a lattice deformer.





## Set up your project

Since this is a new project, you must set a new directory as your current project directory. This will let you separate the files generated in this project from other projects. If you want to look at the final scene for this lesson, refer to the scene *07-boog_05.ma*.

### 1 Set the project

As you have already learned, it is easier to manage your files if you set a project directory that contains sub-directories for different types of files that relate to your project.

- If you copied the support files onto your drive, go to the **File** menu and select **Project → Set...**

  *A window opens pointing you to the Maya projects directory.*

- Click on the folder named *project2* to select it.
- Click on the **OK** button.

  *This sets the project2 directory as your current project.*

OR

- If you did not copy the support files on your drive, create a new project called *project2* with all the default directories.

### 2 Make a new scene

- Select **File → New Scene**.

## Starting the bear

You will build the bear starting from a polygonal cube primitive. Facets will be extruded to create the more complex biped shape required and will then be refined to create the bear shape.

It is important to understand what you will be doing throughout this lesson, so you must plan ahead and breakdown the task into simple stages. The following is how you will approach the character modeling.

#### Torso

The cube primitive will be the pelvis area of the bear. You will then extrude faces up to create the torso, neck and head.

#### Legs

Starting from the pelvis geometry, you will extrude the polygon faces to create the legs.





#### Arms

Starting from the torso geometry, you will extrude polygon faces to create and refine the arms.

Later in the lesson, you will ensure that your model is symmetrical by mirroring it.

> ***Tip:*** *It is a good idea to look at reference images from this project and from the gallery in this book to give you an idea of the finished product.*

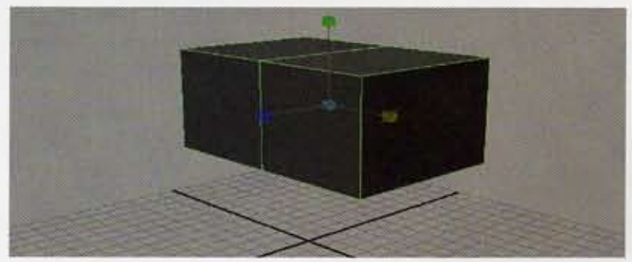
### 1 Primitive cube

- Select **Create → Polygon Primitives → Cube.**
- Press **5** to **Smooth Shade All.**
- **Rename** the cube to *body.*
- From the **Inputs** section of the Channel Box, set the **Subdivisions Width** of the *polyCube1* node to **2.**

  *Doing so will define polygonal edges going down the central line of the character.*

> ***Tip:*** *As a general convention, you should always model your characters facing the scene's positive Z-axis.*

- **Move** the cube up and **scale** it to roughly match the following, which represents the waist of the character:

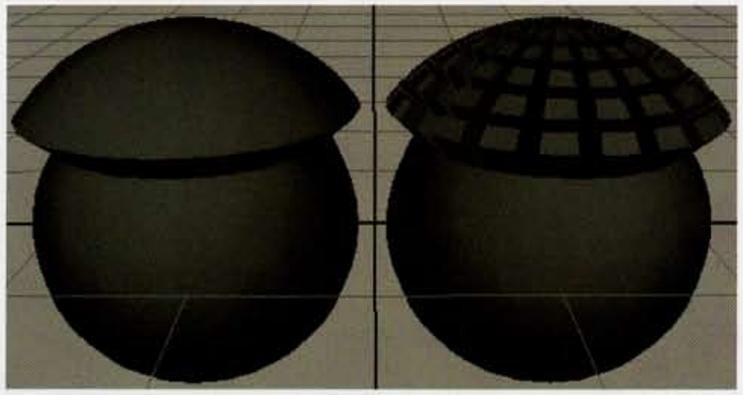


*Start primitive cube*

**Tip:** *When modeling, don't be afraid to model big. You do not want to be stuck working on a tiny model. Use the grid as a reference to represent the floor. You can always edit the proportions of your character later on.*

### 2 Extrude faces

Before extruding the faces, you need to make sure that the **Keep Faces Together** option is enabled. When this option is **On**, it extrudes chunks of facets instead of each facet individually. Following is an example of **Keep Faces Together** both **On** and **Off**:



*The Keep Faces Together effect*

**Note:** *During the process of modeling the orb, make sure that you do not accidentally select, deselect or modify facets that are on the opposite side of the object. If you do, use Ctrl to deselect unwanted components.*

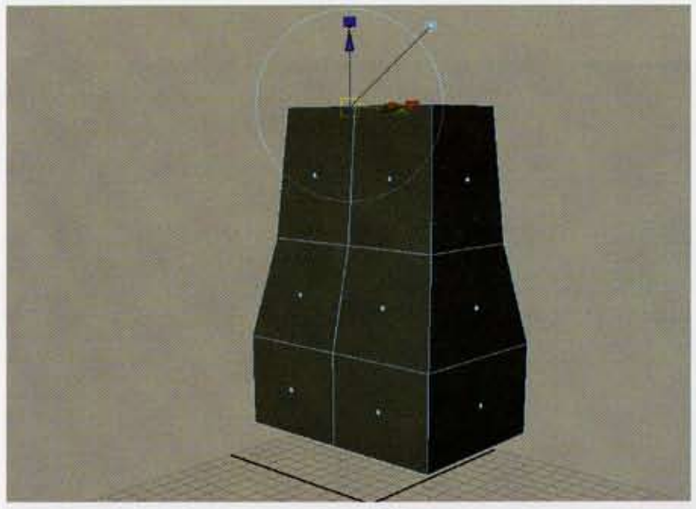
- Select the **Polygons** menu set by pressing **F3**.
- Make sure the option **Edit Mesh → Keep Faces Together** is set to **On**.
- Go in **Component** mode with faces displayed by pressing **F11**, or by setting the selection mask in the Status Bar as follows:





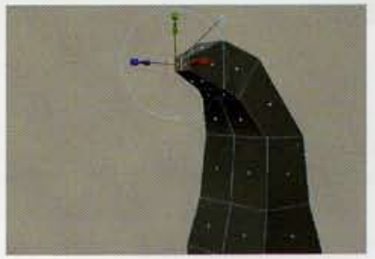
*Component mode with faces enabled*

- Select the two top faces on the cube, then select **Edit Mesh → Extrude**.
- **Move** the faces up in the **Y-axis**.
- **Scale** them in uniformly a little bit.
- **Repeat** the last three steps to get geometry similar to the following image:



*Waist and torso of the bear*

- **Extrude** three more times to make the neck, head and nose of the bear.
- This time, you should also **rotate** the extrusion to make the faces flow into the neck/ head portion of the bear.



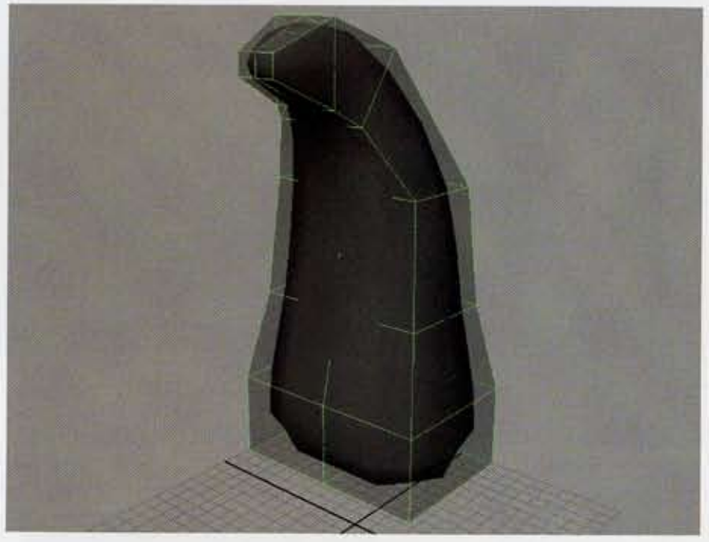
*Neck and head of the bear*

### 3 Subdiv Proxy

So far, you need a bit of imagination in order to see the bear's shape. **Subdiv Proxy** is a simple tool that allows you to see a smoothed version of your model while still modeling on the cube from the previous steps.

- Go in **Object** mode.
- With the cube selected, select **Proxy → Subdiv Proxy**.

  *Doing so displays the original geometry, known as the proxy, with transparency, and displays the smoothed resulting geometry within it. Whenever you will update the proxy geometry, the smoothed version will automatically update. Once you have refined the proxy cage to your needs, you can either get rid of the smoothed version and keep working on the proxy geometry or vice-versa.*



*The proxy and smoothed geometry*

***Tip:*** *You should never tweak the smoothed version of the geometry directly.*

- Press the **[`] hotkey** (the key on the upper left corner of your keyboard), to toggle between the proxy and smoothed geometry.







- Press **Ctrl+`** to toggle between the original geometry and the Subdiv Proxy.

### 4 Extruding the legs

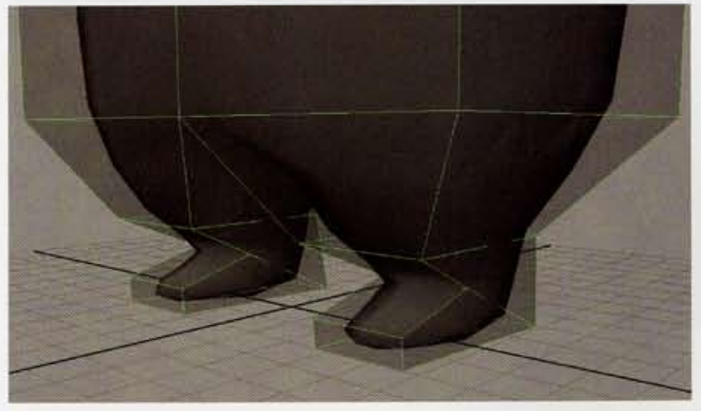
Now that you can see the rough shape of the bear's body, you need to extrude the legs. Here, you will extrude both legs at the same time.

- Select the proxy geometry and display its faces.
- Select the two faces from underneath the pelvis to start extruding the legs.
- Select **Edit Mesh → Extrude**.
- **Move** and **scale** the extruded faces down to the bear's knees.

***Note:*** *When you manipulate the handle associated with one face, the other face reacts equally. Extrusions work according to the normals of the original faces. Normals are lines that run perpendicular to the surface. To view polygon surface normals, select* **Display → Polygons → Face Normals**.



- **Extrude** again to the ankles.
- **Rotate** the faces by about **45 degrees** in order to flow the next extrusion into the feet.



*Leg extrusions*

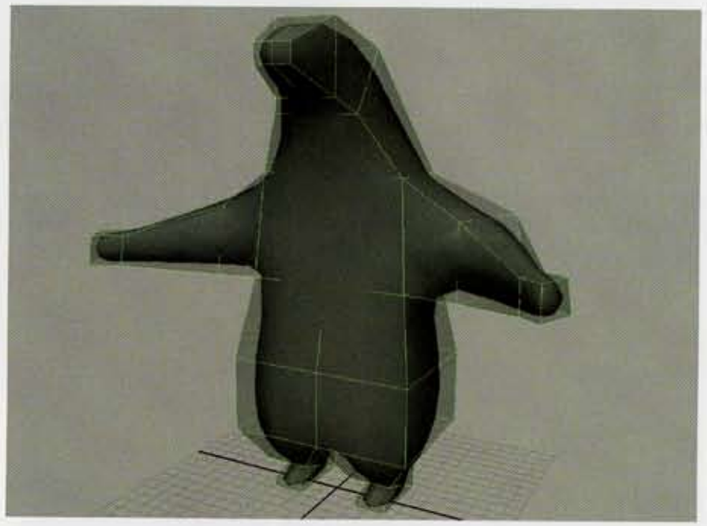
### 5 Extruding the arms

Since you should be concentrating only on the basic shape of the character, you will stop refining the legs here and go right into extruding the arms.

- Select the faces on either side of the torso.

> **Tip:** *While selecting, remember to use Shift to toggle the new selection, Ctrl to deselect and Ctrl+Shift to add the new selection.*

- **Extrude** the arms up to the elbows and roughly **tweak** the placement of the new faces.
- **Extrude** again up to the wrists and roughly **tweak** the placement of the new faces.
- **Extrude** one last time to create the palms, and roughly **tweak** the placement of the new faces.



*The extruded arms*

### 6 Save your work

- Save your scene as *07-boog_01.ma*.







## Shaping the bear

Now that the basic shape of the bear is established, you can concentrate on moving polygonal vertices around to refine the general silhouette of the bear.

> **Tip:** *For a quick look at the silhouette of the character, you can press 7 on your keyboard. Without lights in your scene, this makes an instant black silhouette.*

### 1 Tweak the proxy

In order to define the shape of the bear a little better, you do not need to add geometry yet. Instead, you can edit the proxy geometry's vertices.

- Select the **proxy geometry**.
- Go in **Component** mode with **vertices** displayed.

*Component mode with vertices enabled*

- **Double-click** on the **Move Tool** in the Toolbox to bring up its options.
- In the Move Tool options, set the following:

  **Reflection** to **On**;

  **Center** to **BoundingBox**;

  **Reflection axis** to **X**;

  **Tolerance** to **0.1**.
- Click on the **Close** button.
- Select a vertex on the proxy geometry and **move** its position.

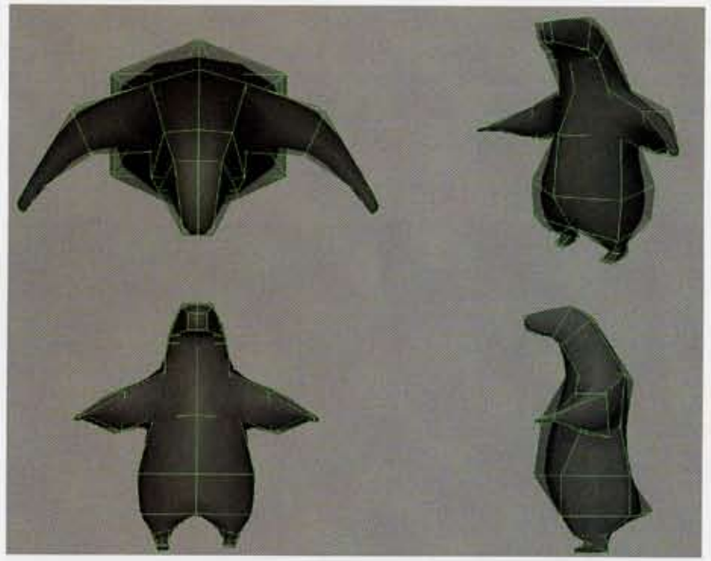
  *Because of the reflection option in the Move Tool, the corresponding symmetrical vertex is also moved.*



> **Tip:** *You should try to do symmetrical edits for this section of the lesson. It is not critical to always do them, but it will help you experience different tools and workflows. Later on in this lesson, you will delete half the model and mirror the geometry to make it perfectly symmetrical.*

- **Tweak** the global shape of the character using the proxy geometry.

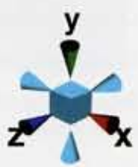
  *It is important to tweak the proxy geometry in order to have the smoothed geometry look good.*



*The refined shape*

### 2 Modeling tips

- With vertices selected, you can press the arrows on your keyboard to traverse the geometry components.
- Make sure to always look through different views when modeling. You can stay in the Perspective view, but be sure to use the **View Compass** located in the upper right corner.




*The View Compass*





- You can turn on the wireframe on shaded option by selecting **Shading → Wireframe on Shaded.** This will allow you to see the underlying geometry on the smoothed geometry.
- Try to not move the central line of vertices on their X-axes. This will make your work easier when you mirror the geometry.

## Refine the bear

You should now need more geometry to play with in order to get the bear to the next level. Here, you will add to the existing geometry in order to better define key areas such as the tail, feet and hands.

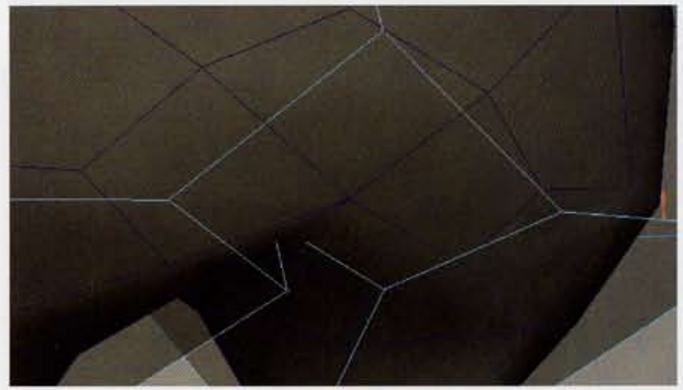
### 1 Chamfer a vertex

Before you can extrude the tail of the bear, you will need an actual polygon face to extrude the tail from. The **Chamfer** command allows you to select a vertex and do the proper face division in order to convert that vertex into a face.

- Select the one vertex located at the lower back of the bear.

  *This is the vertex from which you will extrude the tail.*

- Select **Edit Mesh → Chamfer Vertex.**



*The Chamfered vertex*

> **Tip:** *In the construction history of the polyChamfer node, you can change the width of the chamfered vertex.*



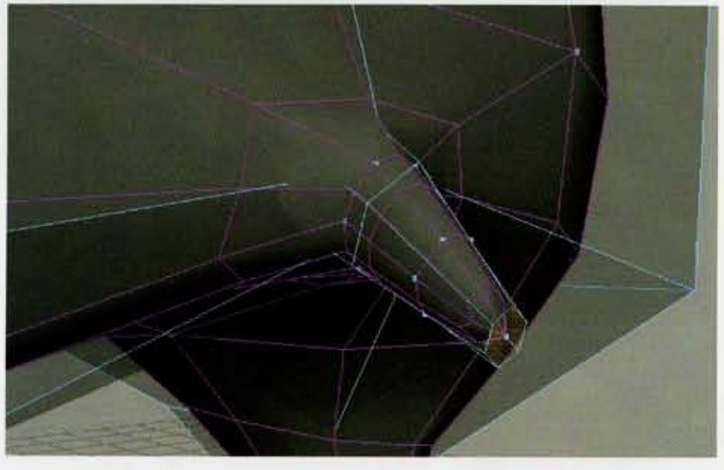
- **Tweak** the positioning of the newly created vertices to make the new face more of a hexagonal shape as follows to the right:

*Proper tail face shape*

***Tip:*** *Select all the tail face vertices and use the Scale Tool to make the face perfectly flat on its Z-axis.*

### 2 Extrude the tail

- **Extrude** the tail face **twice** as follows:



*The completed tail*

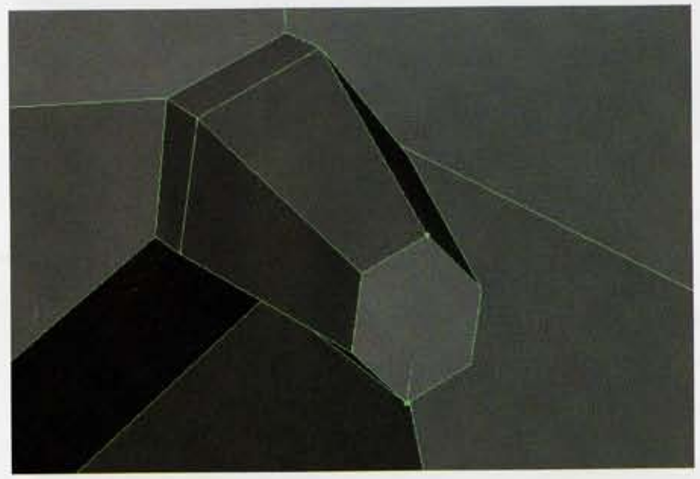




### 3 Splitting a polygon

The last face on the tip of the tail should be split vertically in order to comply with the central line dividing your character along the chest, neck and head.

- Select **Edit Mesh → Split Polygon Tool**.
- **Click+drag** to the top edge of the hexagonal face.
- **Click+drag** to the bottom edge of the hexagonal face.



*The tip face split*

- Hit **Enter** to complete the action.

  *Doing so inserts a vertical edge that starts from the top vertex and splits the face down to the bottom vertex.*

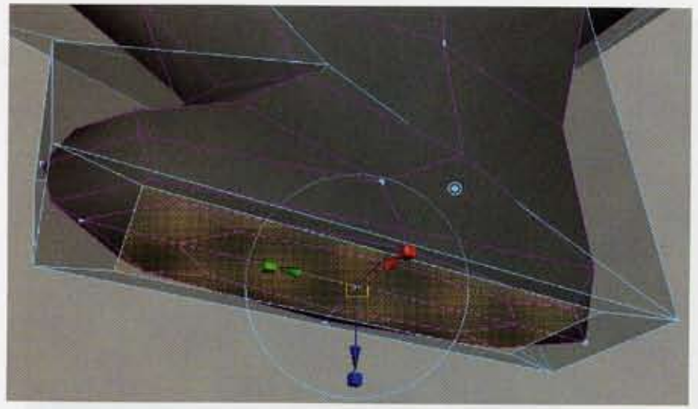
### 4 Flatten the feet

As you can see, the smoothed bear model does not have flat feet. This can be fixed by extruding an additional face underneath the feet.

- Select the faces under both feet.
- Select **Edit Mesh → Extrude**.

  *Doing so forces the smoothed version of the geometry to be flatter in that area.*

- Using the extrude manipulator, **scale** the faces so they are smaller.



*The flat foot soles*

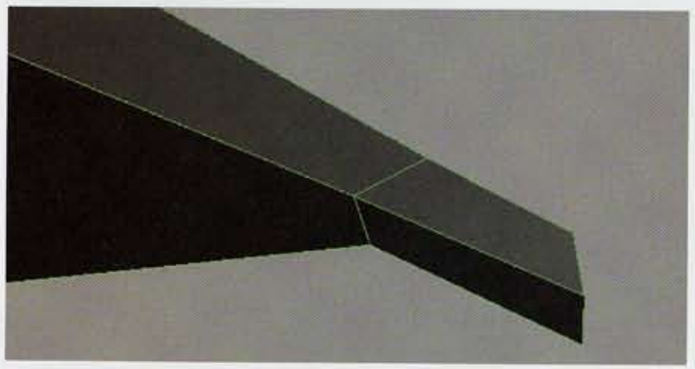
### 5 Thumbs

The hands of your character should be very simplistic, with only long claws coming out of them. The thumb area could still use some definition.

- With the proxy selected, press **Ctrl+'**

  *This reverts the Subdiv Proxy functionality to the body geometry only.*

- **Zoom in** onto one hand of your character.



*The low resolution hand*

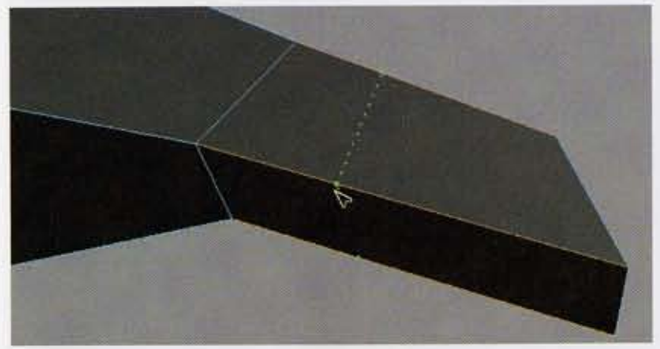
- Select **Edit Mesh → Insert Edge Loop Tool**.





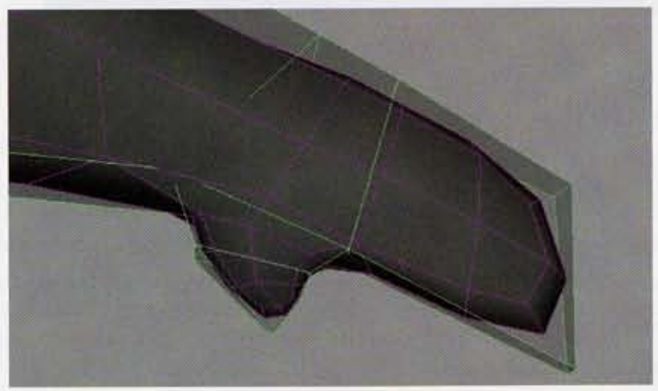
**Note:** *An* **edge loop** *is defined by a continuous line of connected edges. The edge perpendicular to the edge loop is called an* **edge ring**.

- **Click+drag** on one of the palm edges in order to insert an edge loop as follows:



*Inserting an edge loop*

- **Extrude** and **modify** the thumb face in order to bring out the thumb.
- Press **Ctrl+'** to enable the Subdiv Proxy model.
- **Extrude** again and **tweak** the resulting shape as follows:

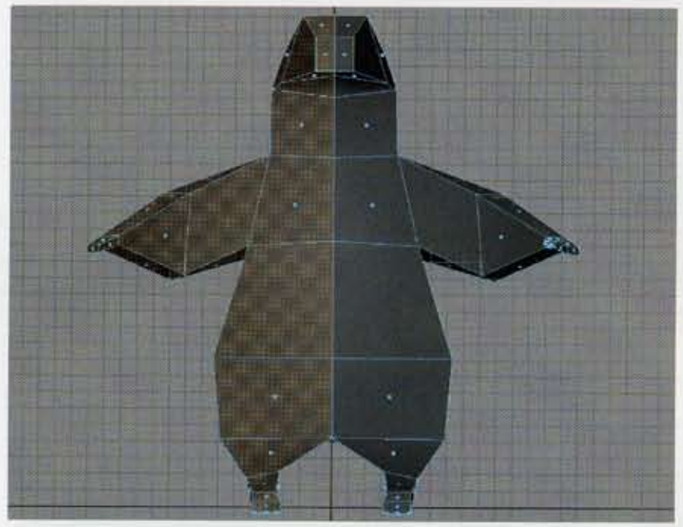


*The extruded thumb*

### 6 Mirror the geometry

The last few steps done to extrude the thumb are not reflected on the other hand. Rather than redoing all the work for the other side, it is simpler to create a mirrored version of your geometry. This will also simplify your work once you begin modeling the character's face.

- With the proxy geometry selected, press **Ctrl+`** to go back to your original *body* geometry.
- From the *front* view, select all the faces on the left side of the character.



*All the left faces selected*

- Hit the **Delete** key on your keyboard.
- Go back in Object mode and select the *body* geometry.
- Select **Edit → Duplicate Special → ❐**.
- In the duplicate options, select **Edit → Reset Settings**, and then set the following:

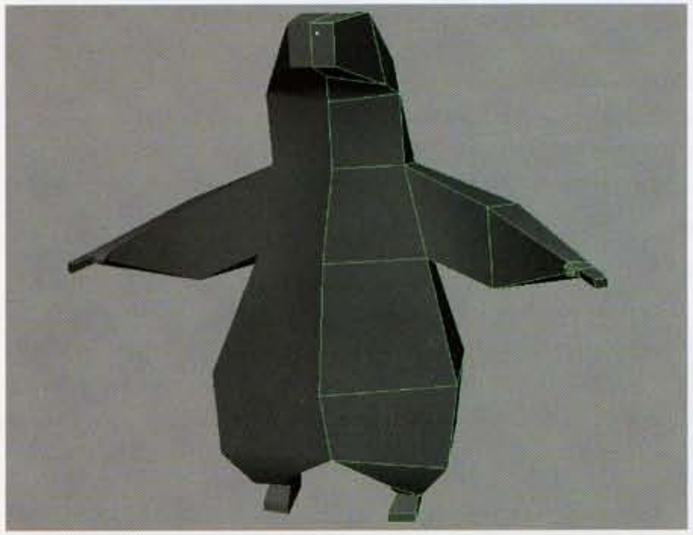
  **Geometry Type** to **Instance**;

  **Scale X** to **-1**.
- Click the **Duplicate Special** button.





*The model is duplicated as a mirrored instance. An instanced object uses the exact same geometry as the original object, except that it can have a different position, rotation and scaling in space. Any adjustments done on one side will simultaneously be done on the other side.*



*The model with instance*

### 7 Save your work

- Save your scene as *07-boog_02.ma*.

## Refine the head

Perhaps the most important part of the character is the face. This exercise will go through some steps in order to refine the head, but most of the work will have to be done by yourself, since this is an artistic task.

Several new tools will be explained here with some key examples that will require experimentation. If you would like to use the final scene of this exercise as a reference, look for the scene *07-boog_03.ma* in the support files.

### 1 Delete the construction history

After all the operations done thus far on the model, the construction history list is starting to look impressive, but also useless. Now is a good time to delete the history on your model. This also deletes history from the entire scene.

- Select **Edit → Delete All by Type → History**.

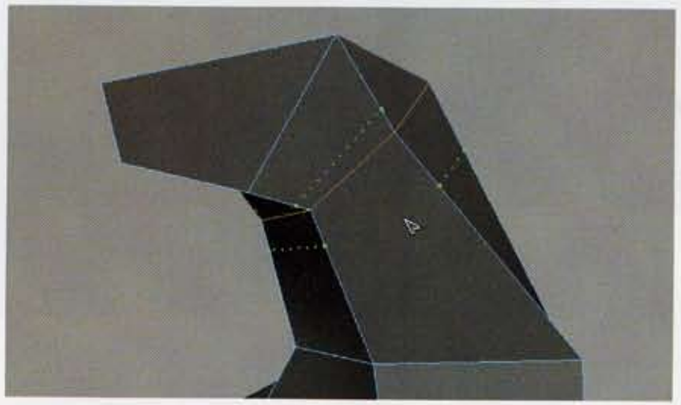
### 2 Offset Edge Loop Tool

The head is now very simplistic and the first step is to add more geometry to play with. You will add several edge loops for the neck and head.

- With the *body* geometry selected, select **Edit Mesh → Offset Edge Loop Tool**.

  *This tool allows you to simply add two edge loops on either side of an existing edge loop.*

- **Click+drag** on any horizontal edge at the top of the neck.



*Offset edge loop*

- **Release** the mouse button to execute the tool and insert the new edges.

### 3 Delete edges

If you need to delete edges, it is possible to simply select them and press the delete key on your keyboard. However, working this way leaves vertices on the perpendicular edges that are not wanted. In order to compensate for this, there is a specialized command that can be used to correctly delete edges and vertices.

- Select **Select → Select Edge Loop Tool**.







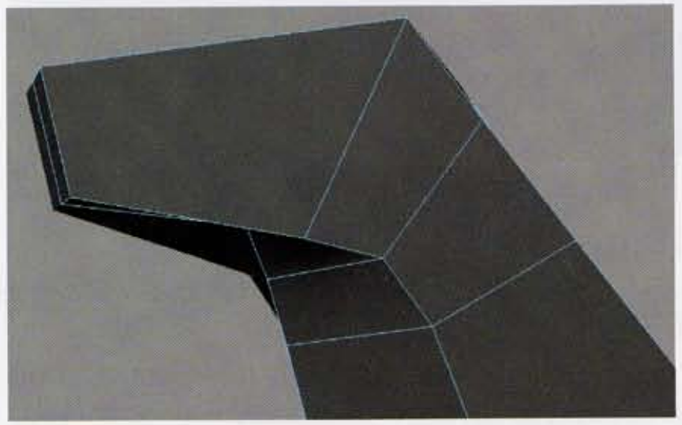
*This tool requires you to double-click on an edge in order to select its related edge loop.*

- **Deselect** any edges by clicking in an empty space in the viewport.
- **Double-click** on one of the edges from which you used the offset command in the last step.

  *The entire edge loop is selected.*

- Select **Edit Mesh → Delete Edge/Vertex**.

  *The entire edge loop is properly deleted.*



*The deleted edge loop*

### 4 Insert an edge loop

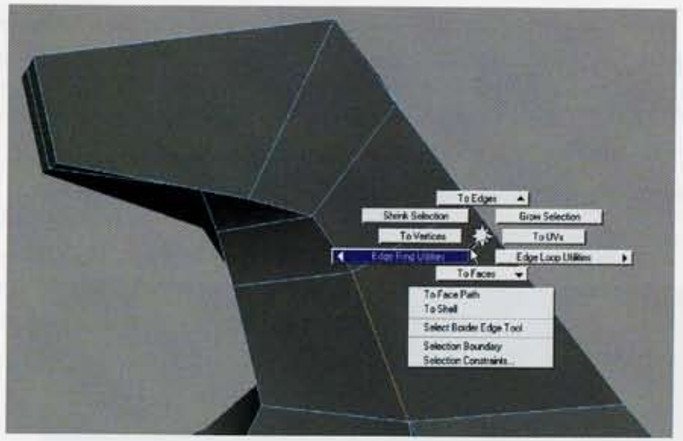
There are several ways to access the different modeling commands other than with the menus. If you like working with the menus, keep doing so, but following is an alternative that involves a hotkey and a Marking Menu.

- **Deselect** any edges from the *body* geometry.
- **Choose** one of the vertical edges from the lower part of the neck.
- Hold down the **Ctrl** key and then **RMB** on the geometry.

  *This brings up a polygonal modeling Marking Menu.*

- From the Marking Menu, select **Edge Ring Utilities**.

  *Doing so automatically pops a second Marking Menu related to edge rings.*




*The modeling Marking Menu*

- Select **To Edge Ring and Split.**

  *The command automatically selects the related edge ring about the chosen edge, and then does a split on those edges.*

### 5 Insert more edge loops

- **Insert** two more vertical **edge loops** on the nose of the character.

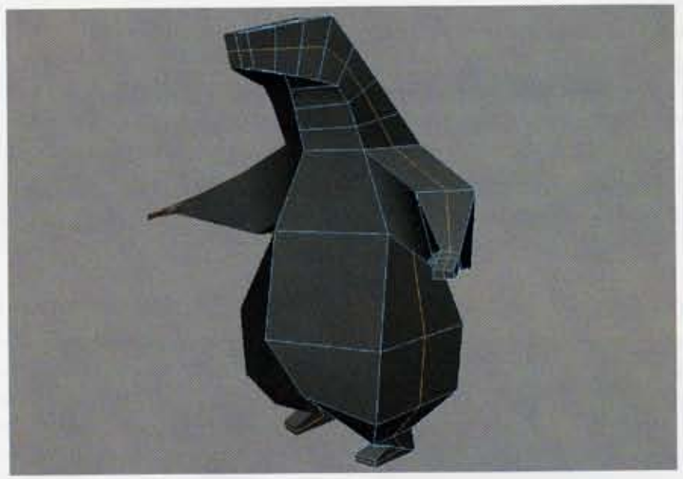
### 6 Split polygons

Notice that when you use the Insert Edge Loop Tool, the tool keeps splitting polygonal faces with four sides. If it encounters polygonal faces with more or less than 4 sides, the tool stops splitting more edges. This can be very useful, but it can also go through your entire character before it stops splitting edges. In order for you to control how many edges are split, the tool has an option that allows you to choose the start and end edge to split. Following is an example of such an application:

- Select **Edit Mesh → Insert Edge Loop Tool.**
- **Click** on one of the vertical edges on the side of the character's head.
- **Undo** the last operation.
- **Double-click** on the **Insert Edge Loop Tool** in the bottom portion of the Toolbox or select **Edit Mesh → Insert Edge Loop Tool → ❐.**



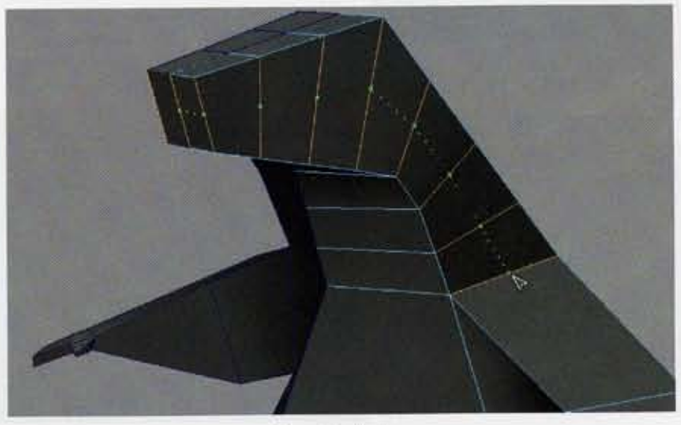




*The Split Tool splits the entire character*

- In the shown window, turn **Off** the **Auto Complete** option.
- Click the **Close** button.
- **Click** the central vertical edge on the tip of the nose.

  *The tool now requires you to choose subsequent edges in order to define an edge loop.*



*The solved edge loop*

- **Choose** the edge at the base of the neck.

  *The tool displays the solved edge loop.*

**Note:** *You can keep selecting other edges to define a longer edge loop. The edges do not need to be part of the same edge ring.*

- Hit the **Enter** key when you are ready to insert the proposed edge loop.

### 7 Tweak the head vertices

There is now much more geometry to refine in the head area. This is where the artistic work comes in, and where you must use your own judgment to define the head to your liking. In the following, you will use different options in the Subdiv Proxy command.

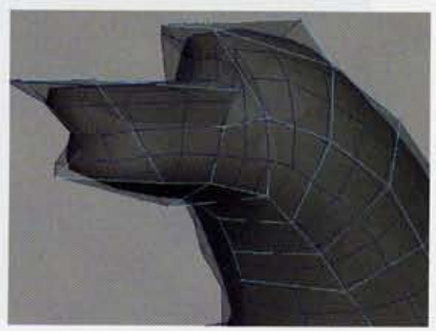
- **Delete** the instanced geometry.
- Select the *body* geometry.
- Select **Proxy → Subdiv Proxy →** ❐.
- Set the following in the option window:

  **Mirror Behavior** to **Full**;

  **Mirror Direction** to **-X**;

  **Merge Vertex Tolerance** to **0.1**.

  *Since your geometry has been split in half, setting this option will automatically make a mirrored and merged geometry.*
- Click the **Smooth** button.
- Select the proxy geometry.
- Go in Component mode with vertices enabled.
- **Tweak** the head vertices as follows:



*The refined head*

### 8 Save your work

- Save your scene as *07-boog_03.ma*.





## Keep on modeling

You now have a good understanding of polygonal modeling basics. By continuing to refine the bear character, you will see that the time spent experimenting will provide invaluable experience. Throughout the modeling process, you can get into trial and error processes that will eventually achieve great solutions. At some point, you will be able to visualize the different steps to take without ever touching the model.

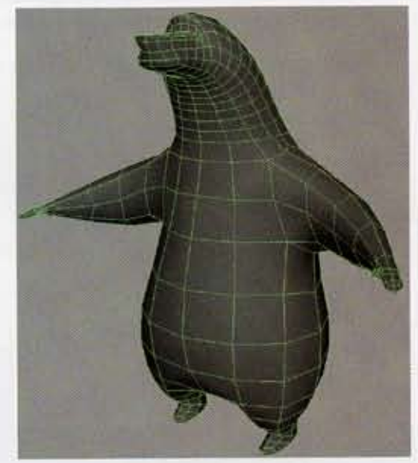
Following are some general directions to finish modeling the head of the character. To see the final scene of this exercise, look for the scene *07-boog_04.ma* in the support files.

### 1 Removing the proxy

The proxy geometry is a great way to create a general shape for your character, but at some point, you will need to refine the smoothed version. Proxy geometry will need to be deleted when refining the higher resolution model.

- Select **Edit → Delete All by Type → History.**

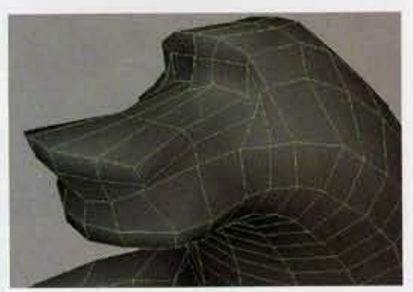
  *Doing so removes any history between the proxy and smooth geometry.*
- Select the *body* proxy geometry and its mirrored instance, and then hit the **Delete** key.
- **Rename** the high resolution geometry to *body*.



*The high resolution model*

### 2 Tweak the vertices

Now that you have more vertices defining your character, you can play with the shape of the bear.



*High resolution refinements*



***Tip:*** *Don't be afraid of moving vertices one by one. You will most likely end up moving each vertex by hand for the entire model anyway.*

While you are tweaking the vertices around the eyes, nose, mouth and ears, try to delimiter the different facial areas with edges. Doing so will help to see the different parts of the face, and it will also make it easier to split polygons to get even more resolution.

### 3 Add divisions

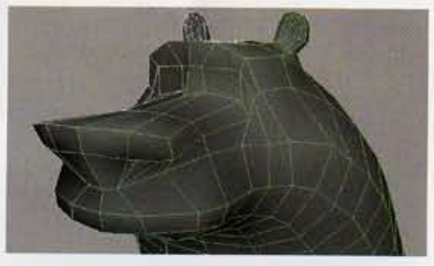
You must now concentrate on splitting and refining only one half of the model. Consider deleting half the model and creating another mirrored instance as shown previously.

- Using the **Split Polygon Tool**, insert new edges where required in order to better define certain areas.

***Tip:*** *As a rule, try to always create four-sided polygons when splitting geometry. Doing so will spare you problems later on.*

### 4 Extrusions

- **Extrude** faces to create the nostrils.
- **Extrude** faces to create the ears.



*The nostril and ear extrusions*

### 5 Soft normals

The extrusion and polygon splits create hard edges by default.

The following shows how to soften polygonal normals.

- With the *body* geometry selected, select **Normals → Soften Edges.**

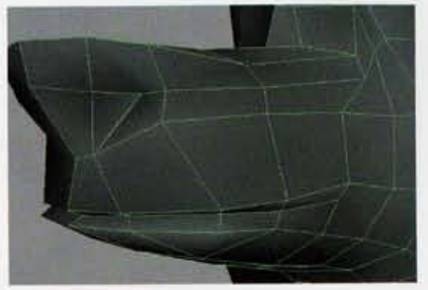
*Soft and hard edges comparison*





### 6 Mouth

For simplicity reasons, you will not see how to model the inner mouth in this lesson. Instead, concentrate on modeling the lips in order to clearly define the mouth.



*The mouth*

### 7 Merging the model

At this point, you can continue refining the model, or call it final and go on with the rest of the project. The following shows how to mirror and merge the actual geometry in order to create a final complete body.

- **Delete** the instanced geometry.
- Select the *body* geometry.
- Select **Mesh → Mirror Geometry →** ❐.
- In the options, specify the Mirror Direction to be **–X.**
- Click the Mirror button.

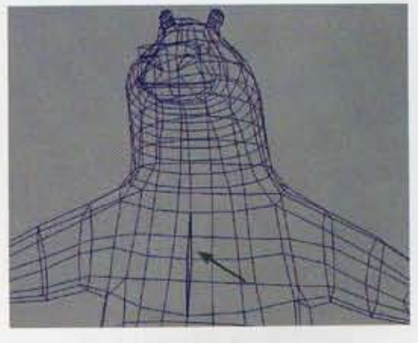
  *The geometry is mirrored and then merged together to create a full body.*

### 8 Merging edges

It is possible that through the process of modeling, you moved central vertices off the mirror plane, causing the geometry to have opened edges along the central axis. The following shows how to merge those edges:

- Select the *body* geometry.
- Select **Display → Polygons → Border Edges.**

  *Doing so causes border edges to be displayed with a thicker wireframe line.*
- Press **4** to see your model in wireframe.



*An open edge*



- Select **Edit Mesh → Merge Edge Tool**.

  *This tool allows you to choose two edges and force them to merge together.*

- **Choose** any of the opened thicker edges.

  *Possible edges to be merged with are highlighted in pink.*

- **Choose** the pink edge located on the other half of the model.
- Hit **Enter** to merge the edges.

  *The edges should not be closed.*

- **Repeat** the previous steps for any other open edges.

### 9 Final steps

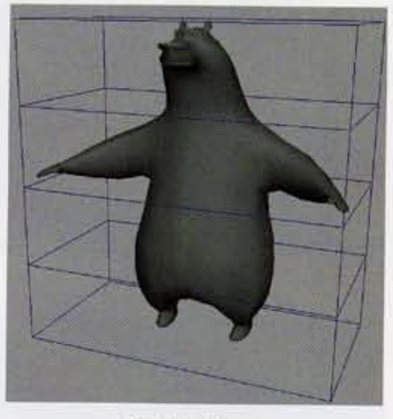
- With the *body* geometry selected, select **Normals → Soften Edges.**
- Select **Edit → Delete All by Type → History.**

### 10 Save your work

- Save your scene as *07-boog_04.ma.*

## Proportions

Sometimes when modeling, you sit back and look at your work thinking you could improve the proportions of the model. An easy way to change a model's proportions is to create and modify a lattice deformer. A lattice surrounds a deformable object with a structure of points that can be manipulated to change the object's shape. Once you are happy with the new proportions, you can simply delete the history, thus freezing the deformations on the models.



*The lattice deformer*

### 1 Create a lattice deformer

- Select the *body* geometry.
- From the **Animation** menu set, select **Deform → Create Lattice**.

  *A large lattice box is created around your model.*





- In the Channel Box with the lattice selected, set the *ffd1LatticeShape* node as follows:

  **S Divisions** to 5;

  **T Divisions** to 5;

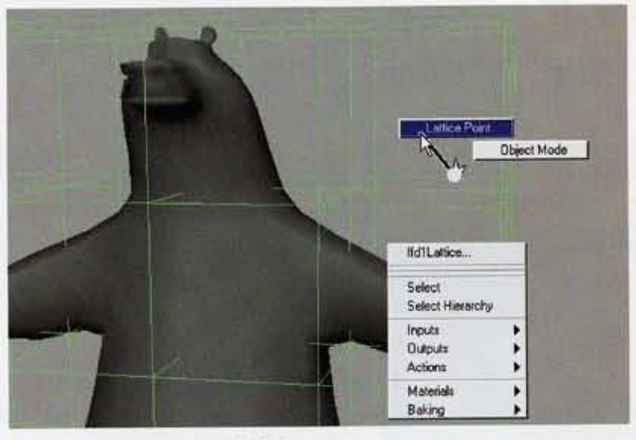
  **U Divisions** to 3.

  *Doing so will change the amount of subdivisions in the lattice deformer, which in turn adds more lattice points to deform the surface with. This will allow more control over the deformations.*

> ***Tip:*** *You may adjust those settings to better fit your geometry and divide the model into body part sections.*

### 2 Deform the lattice box

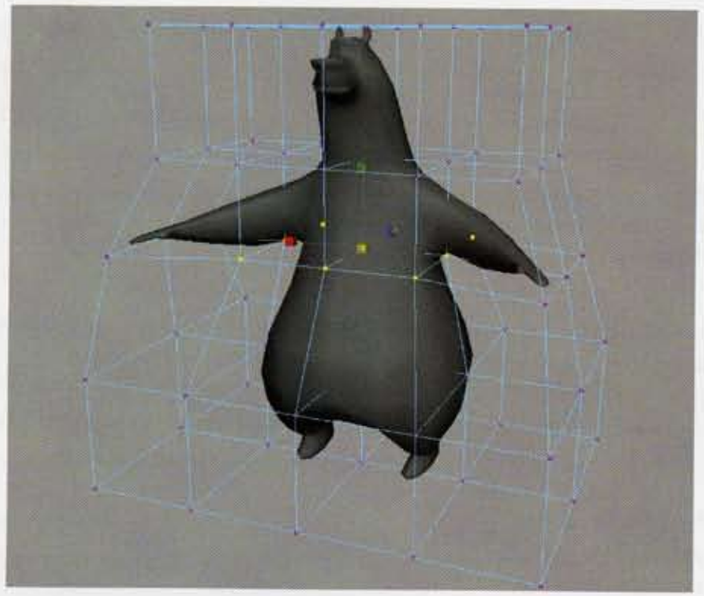
- **RMB** on the lattice object in the viewport to bring up the lattice context menu and select **Lattice Point**.




*The lattice context menu*

- Select lattice points and **transform** them just like you would do with vertices.

  *Notice how the lattice points deform the geometry.*



*Lattice effect*

- Find the best proportions possible.

**Tip:** *This is a good time to place the character's feet on the world grid, if they are not already. Also, make sure to place the model's center of gravity centered on the Z and X-axes.*

### 3 Delete the deformer

If you would simply delete the lattice deformer, the geometry would snap right back to its original shape. In order to keep the deformation and freeze the geometry with that shape, you need to delete its history, which will automatically delete the deformer.

- Select the body geometry.
- Select **Edit → Delete by Type → History.**





## Final touches

The body of the bear looks great, but Boog is still missing key components such as eyes and claws. Those objects will be created starting from NURBS primitives.

Just like the rest of this lesson, you will model only half the geometry and then mirror it over to the other side.

### 1 Eyeball

- Select **Create → NURBS Primitives → Sphere.**
- **Rename** the sphere to *eyeball.*
- **Translate** and **scale** the *eyeball* to the proper eye location.
- **Rotate** the *eyeball* by **90** degrees on its **X-axis.**

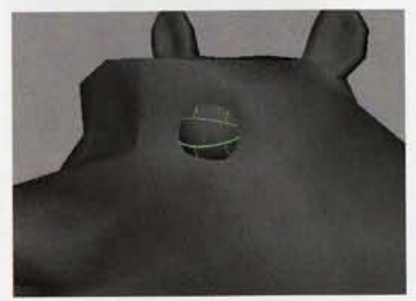
*The eyeball in place*

### 2 Eyelid

- With the *eyeball* selected, select **Edit → Duplicate Special → ❐.**
- In the shown window, select **Edit → Reset Settings**, then turn on the **Duplicate input** graph option.

  *This option duplicates the geometry along with all its inputs, such as construction history, which will be used here.*
- Click the **Duplicate Special** button.
- **Rename** the duplicate to *eyelid.*
- From the Channel Box, **rotate** the eyelid by **-90** degrees on its **Y-axis.**
- **Scale** the *eyelid* so that it is a little bigger than the *eyeball.*
- In the Channel Box, highlight the *makeNurbsSphere2* input node.
- Set the **Start Sweep** to **20** and the **End Sweep** to **340.**

  *The eyelid will use its construction history in order to simplify the eye blinks.*



*The eyelid*

### 3 Claws

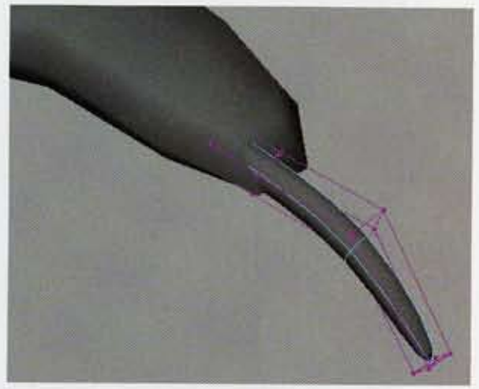
- **Create** a NURBS cone primitive.
- Set the makeNurbsCone input node as follows from the Channel Box:

  **Radius** to 0.2;

  **Sections** to 4;

  **Spans** to 2;

  **Height Ratio** to 10.
- **Rename** the cone to *claw1*.
- **Place** and **tweak** the claw's shape as in the adjacent image:
- **Duplicate** the claw in order to create all the other ones for the hand and foot.



*The first claw*

**Tip:** *You can go in the duplicate options and select Edit → Reset Settings before duplicating the first claw since the construction history is not required.*

*Hand claws*

*Foot claws*

### 4 Mirror the objects

- Select the *eyeball*, *eyelid* and all the *claws*.
- Press **Ctrl+g** to group them all together.

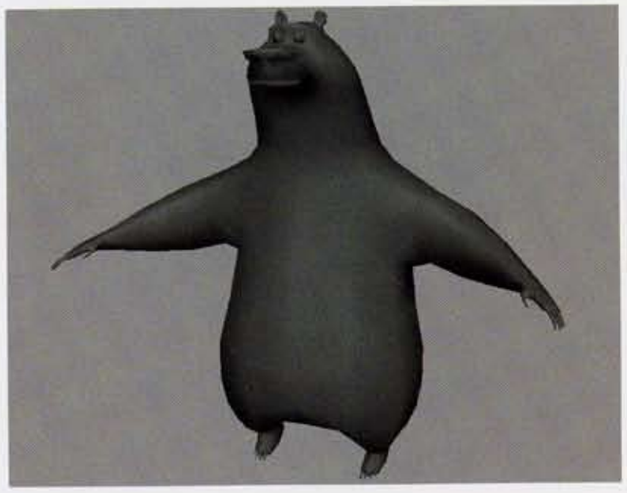




- With the *eyeball* selected, select **Edit → Duplicate Special →** ❐.
- In the shown window, turn on the **Duplicate input** graph option.

  *Doing so will duplicate the required construction history on the eyelid.*
- Click the **Duplicate Special** button.
- In the Channel Box with the duplicated group still selected, set **ScaleX** to -1.

  *You now have all the objects for both sides of the character.*



*The full character*

### 5 Save your work

- Save your scene as *07-boog_05.ma*.

## Conclusion

In this lesson, you learned how to model a complete character out of basic polygonal primitives. In the process, you used several polygonal modeling tools to create the shape and details. As you noticed, each tool created an input node for which you were able to modify the construction history. You also used the lattice deformer, which is a great deformer to know about.

In the next lesson, you will texture the bear. This will allow you to experiment with polygonal texture tools and techniques.