Section IV: Blender

In this section, you'll learn how to use Blender — a free 3D modeling and animation tool — to create great-looking assets for your games.

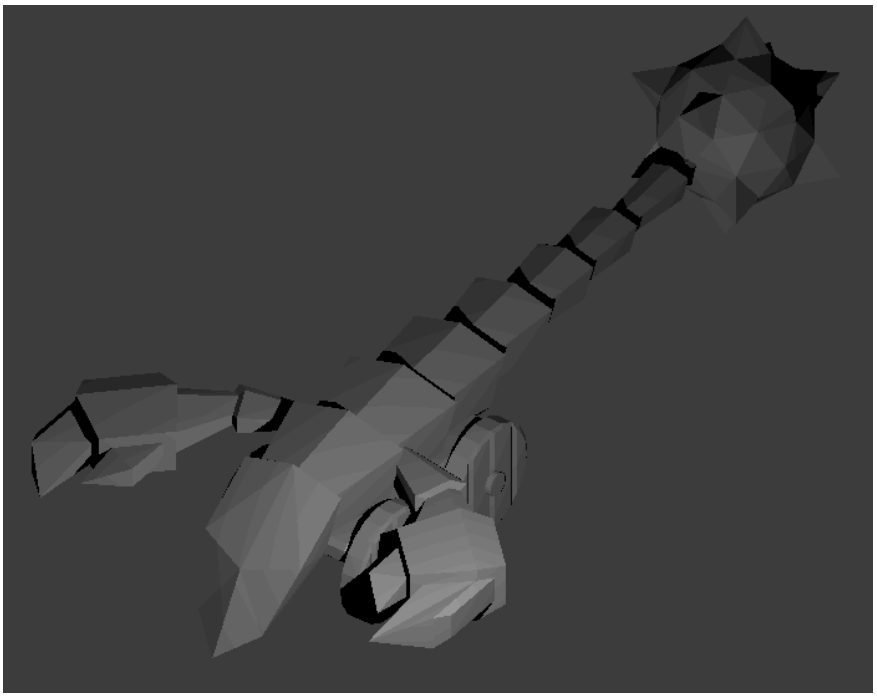
Along the way, you will create a scorpion enemy from scratch: including modeling, texturing, and animating.

Chapter 15: Modeling in Blender

By Mike Berg

Blender is a free 3D modeling and animation tool. It is widely used and actively supported, but many game developers are immediately daunted by its unique user interface. Blender is very powerful, though, and more than capable of fulfilling your 3D asset creation needs — once you know the basics!

In this chapter, you'll learn the basics of modeling in Blender as you build this formidable enemy below:



Getting started

Before you dive in, make sure you have a 2-button mouse with a scrollwheel. You should be able to click down on the scrollwheel itself for a middle click. You will need all three of these buttons while using Blender.

Download Blender

Go to the Blender website to download Blender for Windows, Mac or Linux:

https://unite.unity.com/

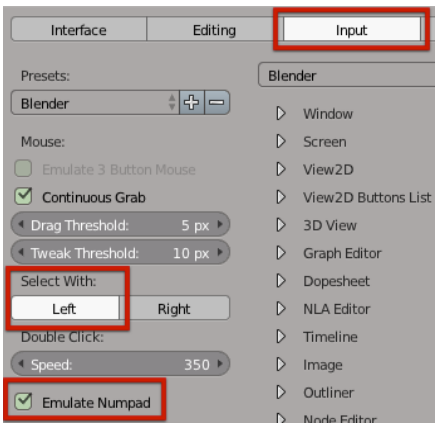
Setting some defaults

By default, Blender selects object with the right mouse button, and performs actions with the left mouse button. By keeping the selection of an item separated from the action on item, you are less likely to select and move an item by mistake.

This makes Blender very awkward to beginners, but you get used to it in time. That said, you can still change it so the left mouse button both selects and acts on an object, as is common with almost every application on Earth.

Open the preferences by selecting **File\User Preferences**. Click the **Input** tab at the top, then click the **Select With: Left** button. This changes your left mouse button to be your primary selection tool.

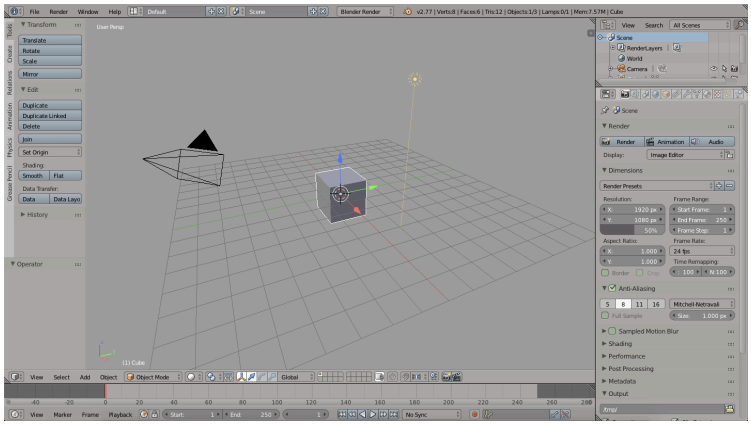
Secondly, if you are using a laptop — or any keyboard without a number pad — select the **Emulate Numpad** checkbox. This allows you to change the 3D view using the top row of numbers on your keyboard. you'll learn more about that a bit later.



Click the **Save User Settings** button at the bottom, then close the preferences window.

Note: Blender's efficiency relies heavily on keyboard commands. They are even designed to be primarily on the left side of the keyboard, so that you can keep your left hand on the keyboard and your right hand on the mouse (with apologies to you lefties!). You will primarily be using keyboard commands when possible.

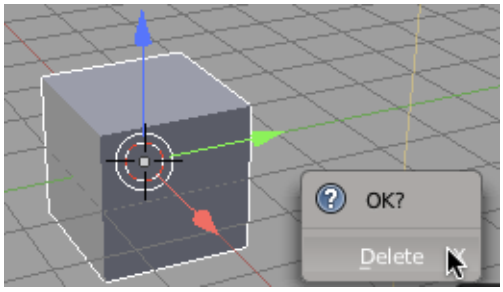
Creating your first model



When you first open Blender, there's a cube in your scene. You're going to start with the wheels of the scorpion, so you don't need the cube. The thin white border around an object shows that it is selected, so delete it by pressing... the Delete key?

Nope, not in Blender! Remember, common keyboard commands are on the left side of the keyboard, and the Delete key is *miles* away on the right side of the keyboard.

Press **X** to delete. A confirmation will appear right under your cursor. Click it to delete your object.

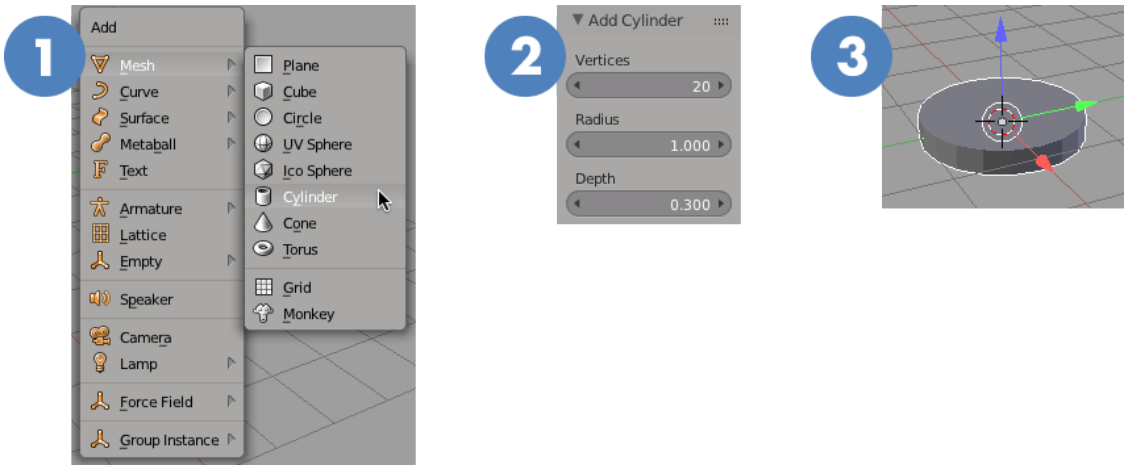


Note: Hotkeys in Blender are specific to the panel your cursor is currently over. If a hotkey doesn't work as expected, move your cursor over the **3D View** in the middle of your screen and try again.

Re-inventing a wheel

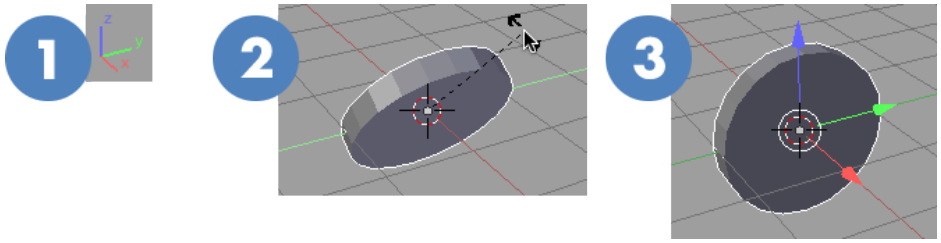
Start by creating a cylinder for the wheel. To create a new object, press **Shift-A**.

1. A popup appears under your cursor. Select **Mesh\Cylinder**.
2. Before you do anything else, you'll have to change some settings. At the lower-left of your screen, set the **Vertices** to **20**, and the **Depth** to **0.3**.
3. You should now have a cylinder that looks like this:



Stand the wheel up on edge by pressing **R** to rotate it. Blender immediately enters a rotation mode; moving your cursor rotates the object freely.

1. Have a look at the small axis indicator at the lower left. You want to rotate the cylinder on the **Y axis**.
2. Press **Y** and your rotation snaps to the y axis (note the green line through your model, indicating this).
3. You can drag your cursor around to rotate it, but for precise rotation simply type **90** and press **Enter** to complete the rotation.



To recap: rotating an object is as simple as quickly typing one command, **R Y 90 Enter**.

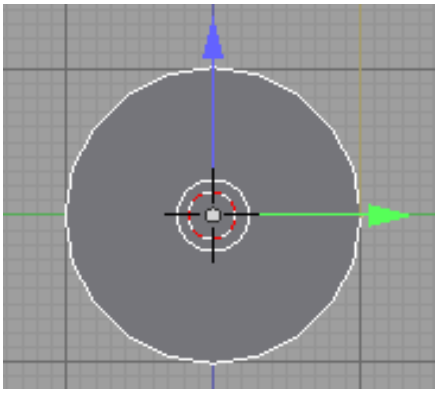
Note: This also works for both moving (type **G** for Grab) and scaling (type **S**), where the first command is the type of translation (move, scale or rotate), the second is the axis, and the third is the distance, scale factor, or angle.

The view from here

Before you edit the wheel any further, change the view so that you only see the side of it. Here are the keyboard shortcuts for changing the 3D View:

- **1**: Front View
- **3**: Side View
- **7**: Top View
- **5**: Toggle perspective

Press **3 5** to get a side view, with perspective turned off.



Edit Mode

Now the real fun begins. Get ready to edit some polygons!

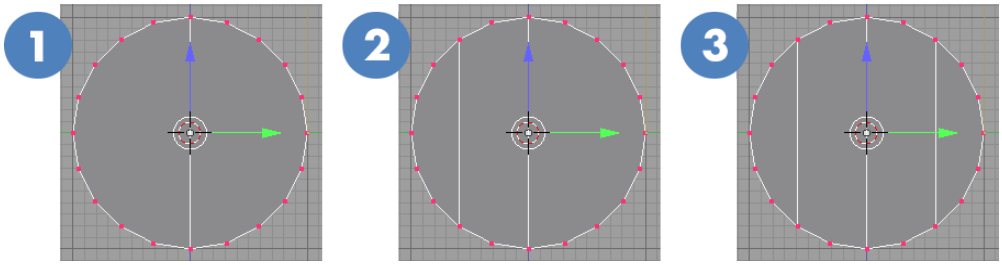
Blender has several modes; right now you'll cover **Object Mode** and **Edit Mode**. In Object Mode, you position objects within your scene. In Edit Mode, you edit the polygons of an object. Press **Tab** to toggle between these two modes. You'll see the popup at the bottom of the view change:

Note: It can be easy to forget which mode you are in while working. Be sure to check the popup above if something isn't working as you expect; you might be trying to do something in Edit Mode that can only be done in Object Mode, and vice versa.

Slice-n-dice with the Knife tool

The **Knife** tool creates a new edge on a face, cutting it in two. Create some boards on the front of the wheel by cutting it into four separate faces:

1. Press **K**, click once on the top-middle vertex, then click on the bottom vertex and press **Enter** to complete the operation. (*Operation!* Polygon surgery... Badum-ching!)
2. Repeat the process for the vertices shown here...
3. ... and here.

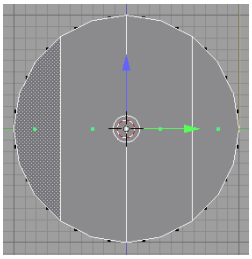


Mesh Select Mode

While in Edit Mode, sometimes you want to work just with points (vertices), sometimes with edges, and sometimes with entire faces. There are three options for working with these elements of your mesh: **Vertex Select**, **Edge Select** and **Face Select**. Switch between them by pressing **Ctrl-Tab**, or by using the toggle buttons at the bottom of the 3D View.

Switch to **Face Select**:

Select the four newly-created faces by clicking one, then holding **Shift** and clicking the others. Selected faces are highlighted.



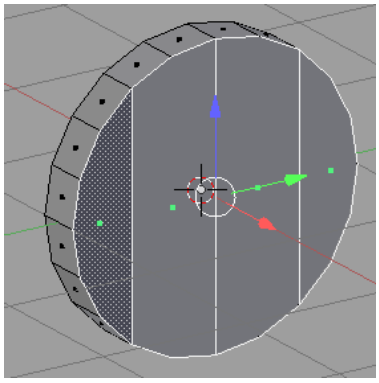
Note: If you make a mistake with a selection, undo works the same for selections as any other action. You can also press **A** to toggle "select all" and "select none".

Orbiting the camera

You need a slightly different view of your model to see the next operation properly. **Middle-click and drag** to orbit the camera around your model.

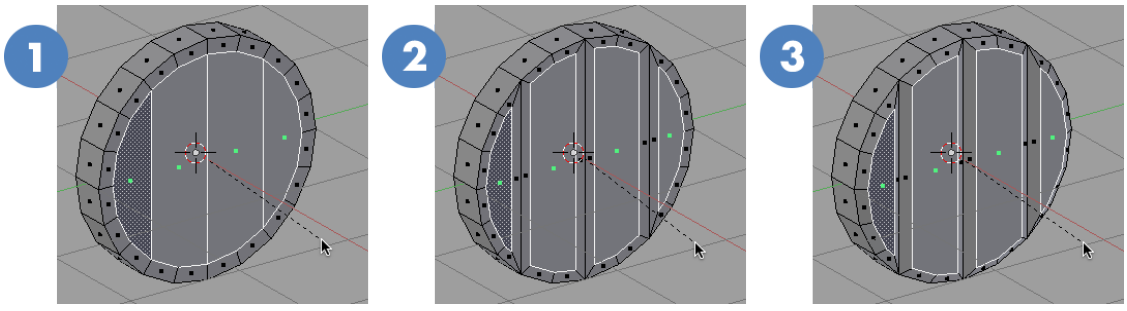
> **Shift + middle-click + drag** to pan the view, and use your scroll wheel to zoom in and out.

Orbit around your wheel to get a view similar to this:



The Inset tool

The **Inset** tool creates a smaller copy of the currently-selected face.

1. Press **I** to invoke the Inset tool. Drag the cursor toward the center of the object and the inset adjusts.
2. You want each individual face to be inset, rather than the whole group of faces. Press **I** again to enter the tool's **Individual** mode.
3. While the Inset tool is still active, you can adjust the height of your inset to create a beveled edge around each of these faces. Hold the **Ctrl** key and drag away from the center of the object to adjust the height. **Left-click** to complete the operation.
4. 

That's it for your wheel! Press **Tab** to return to Object Mode.

Note: Now would be a good time to save. Press **Ctrl-S** to save. You can find a copy of this file in the Resources folder: **Scorpion 01-Wheel.blend**.

Making the axles

Add a cylinder to use as an axle:

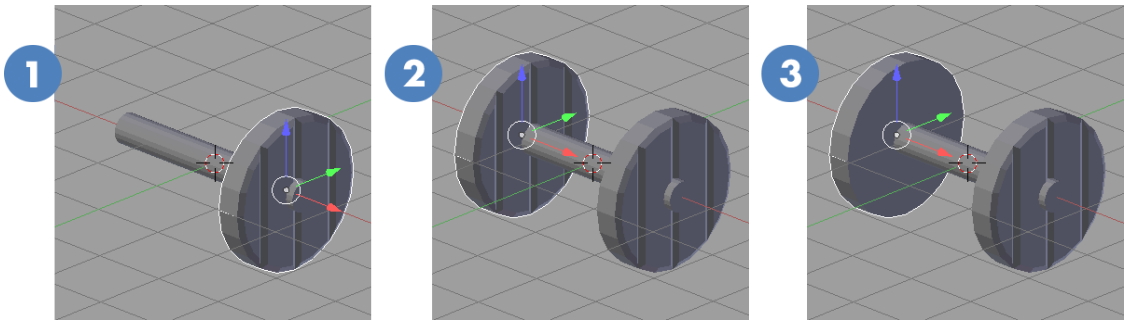
1. Press **Shift-A** and select **Mesh > Cylinder**. In the tool options on the left, set the depth to **3**.
2. Type **R Y 90** and press Enter to rotate it.
3. Type **S Shift-X 0.2** to scale the axle. Note that pressing **Shift-X** *excludes* that axis from the scale operation; the object scales only on the Z and Y axes. This works for move and rotate operations, too.

Note: If your new object doesn't appear at the center of the scene, you may have accidentally moved the **3D Cursor** (a dotted red and white circle) by right-clicking in the 3D view. All new objects are aligned with the 3D cursor. Reset it to the center of the scene by pressing **Shift-S** and selecting **Cursor to Center**.

Duplicating the wheel

Click the wheel object to select it.

1. Type **G X 1.2** and press Enter to move the wheel to the end of the axle.
2. Type **Shift-D X -2.4** and press Enter to duplicate the wheel. Adding the axis and distance immediately moves your duplicate along the specified axis. The second wheel is now exactly where it needs to be.
3. Type **R Z 180** to rotate the wheel so that the beveled faces are pointing outward.

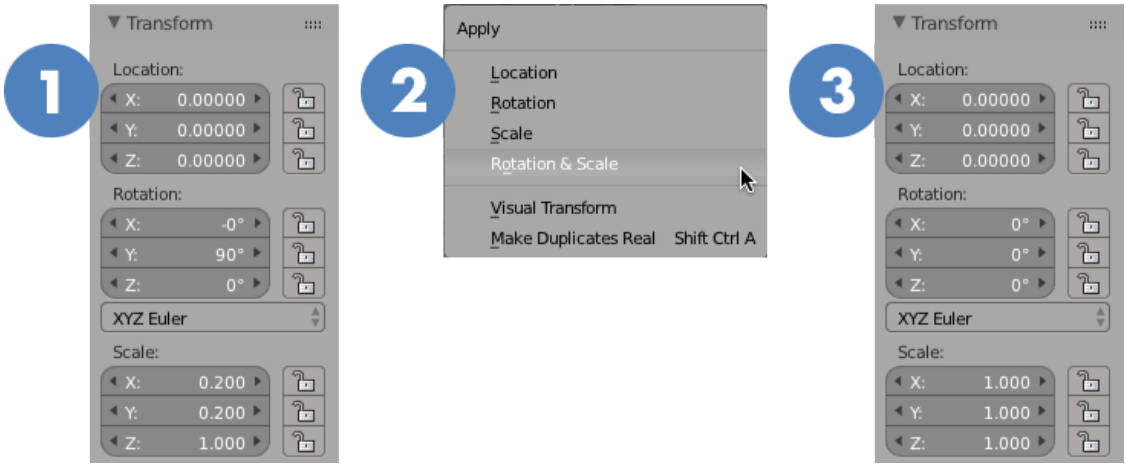


Applying transformations

When modeling for Unity, it's very important to apply the rotation and scale of all objects. After scaling an object to the size you want, applying the transforms will reset the scale values to 1 and the rotation values to zero.

You **will** have scale and rotation problems with your 3D models in Unity, if you don't do this!

1. Click the axle to select it, and press **N** to display the Properties Region. Notice that both the rotation and scale values have been modified.
2. Press **Ctrl-A** and select **Rotation & Scale**.
3. The object doesn't change shape, and all the values are now nice and clean.



Be sure to **Apply Rotation & Scale** for each of the wheels as well.

Joining objects

Since these three objects are going to be animated as a single object in Unity, it makes them easier to work with if they are combined into a single object.

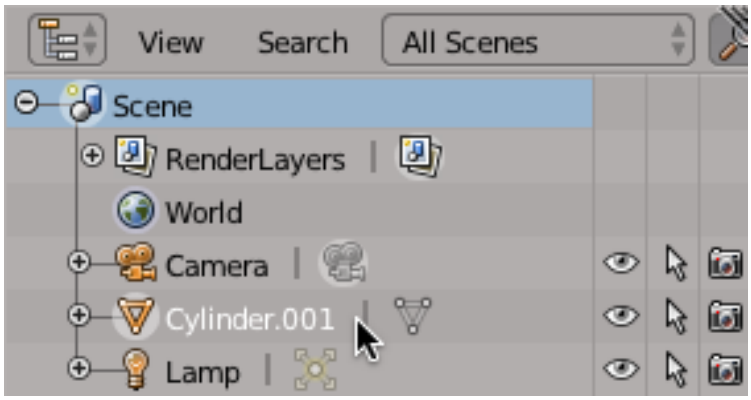
Click one of the wheels to select it, then hold **Shift**, click the other wheel, then the axle. It's important to select the axle **last**. Press **Ctrl-J** to join them.

Note the dot at the center of the object. This dot is the **origin** of your object. Transformations applied to the object will center around the origin, both in Blender and in Unity. When joining objects, the *last object selected* is the one that keeps its origin.

Note: If you ever need to reset an object's origin, make sure you are in **Object Mode**, then use the menu at the bottom of the 3D View to select **Object\Transform\Origin to Geometry** to snap the origin to the center of its geometry.

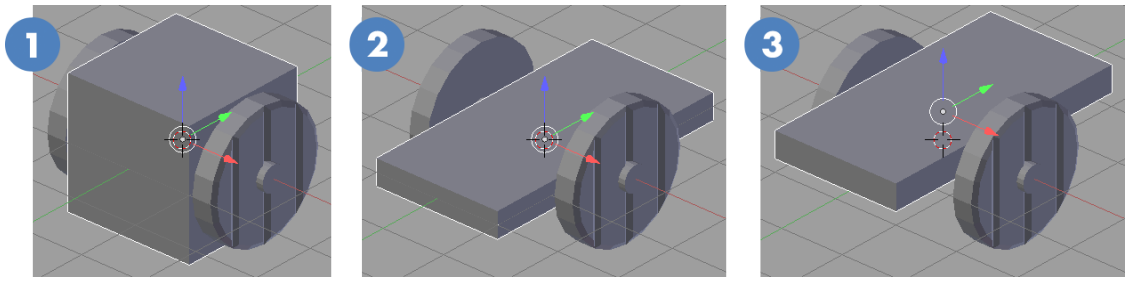
Renaming objects

Since you will want to animate this object in Unity, it will be helpful to give it a recognizable name. The top-right panel in Blender is the **Outliner**. Double-click the cylinder object's name to change it to **axle**:



Adding the base

1. Create a new cube by pressing **Shift-A** and selecting **Mesh\Cube**.
2. Scale it twice: type **S Z 0.2** and press Enter, then type **S Y 2** and press Enter.
3. Move it up a bit, so that it's sitting on top of the axle. Type **G Z 0.4** and press Enter.



The Bevel tool

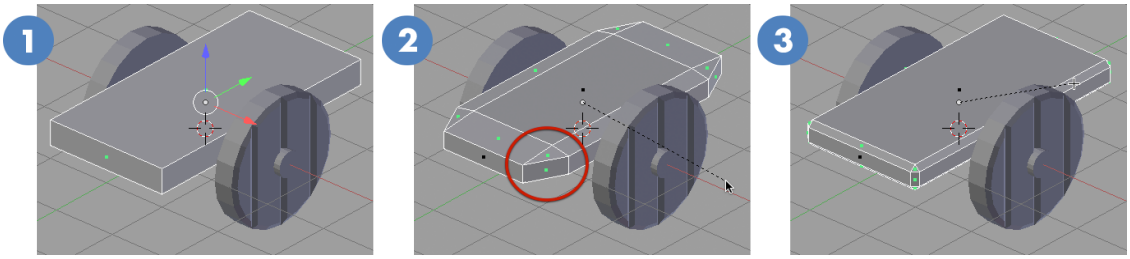
The Bevel tool creates a bevelled edge on your object.

1. Select the base and press **Tab** to enter Edit Mode. All the faces of the cube are likely already selected. If not, Press **A** to Select All.

2. Press **Ctrl-B** to invoke the Bevel tool. Drag away from the object's origin to increase the size of the bevel. Notice how the bevel is not evenly applied to all edges. You want a nice 45-degree angle all the way around your base. This is another effect of not using the previously-mentioned **Apply Rotation & Scale** feature.

   Press **Esc** to abort the Bevel operation, then press **Tab** to exit Edit Mode. Press **Ctrl-A** and select **Rotation & Scale**. Press **Tab** to return to Edit Mode.

3. Press **Ctrl-B** and drag to adjust the size of the bevel. Note how the bevel is now applied the way you want it. When you are happy with the bevel size, click to finish the Bevel. Press **Tab** to exit Edit Mode.



Note: While dragging the size of the bevel, try scrolling the scroll wheel on your mouse. This increases the roundness of the bevel. Nice!

Duplicating the axle for the back wheels

Start by moving the existing axle.

1. Click the axle to select it. Move it by typing **G Y 1.3** and pressing Enter.

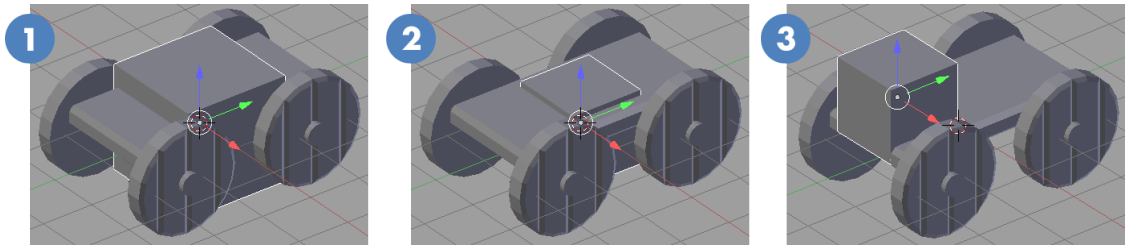
2. There's another way to duplicate an object called **Duplicate Linked**. This creates a copy of the **object** — which can be moved, rotated and scaled — that shares the same **mesh** as the original. Changes to one mesh will be made to both objects. This will come in handy in the next chapter where you apply color to the mesh; colors applied to one object will be applied to both. Create a linked duplicate, and move the axle by typing **Alt-D Y -2.6** and pressing Enter.

Note: One way to remember the difference between the regular Duplicate (**Shift-D**) and a Linked Duplicate (**Alt-D**) is that "Alt" has the letter "L" in it, for "Linked".

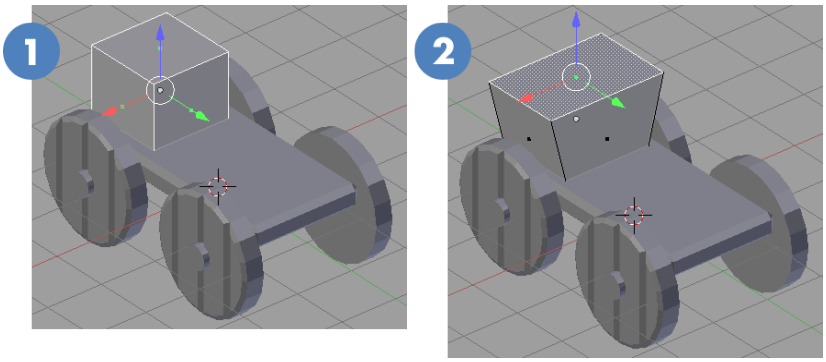
Don't forget to press **Ctrl-S** to save. You can find a copy of this file in the Resources folder: **Scorpion 02-Base.blend**.

Modeling the body

1. You need another cube for the body: create one using **Shift-A**.
2. Scale it: type **S 0.7** and press Enter.
3. Move it up: type **G Z 1** and press Enter. Move it forward: type **G Y -1.3** and press Enter.



4. **Middle-click and drag** to orbit around to see the other side of the cube, and press **Tab** to enter Edit Mode.
5. Press **Ctrl-Tab** and ensure you are in **Face Select Mode**. Select the top face of the cube. Remember, press **A** to Select None if there were already faces selected when you entered Edit Mode. Type **S X 1.5** to make that face a bit wider.

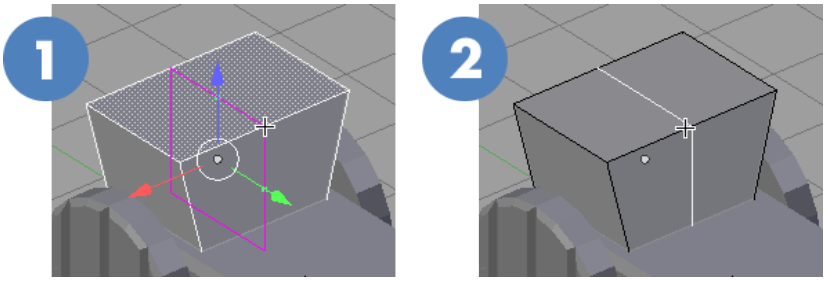


Loop Cut

Making a **Loop Cut** is similar to using the Knife tool, but it makes a cut through the middle of multiple connected faces. You want to create a ridge along the back of the scorpion that sticks up a bit. The Loop Cut tool is perfect for this.

1. Press **Ctrl-R** to invoke the Loop Cut tool. Hover the cursor over an edge and you'll see a line appear, showing a preview of how the loop will be cut. Move your mouse over the edge shown here. **Left-click** once.
2. By default, the loop cut is positioned exactly in the center, and that's what you want. Without moving your mouse, **left-click** again to accept the position and apply the loop cut.

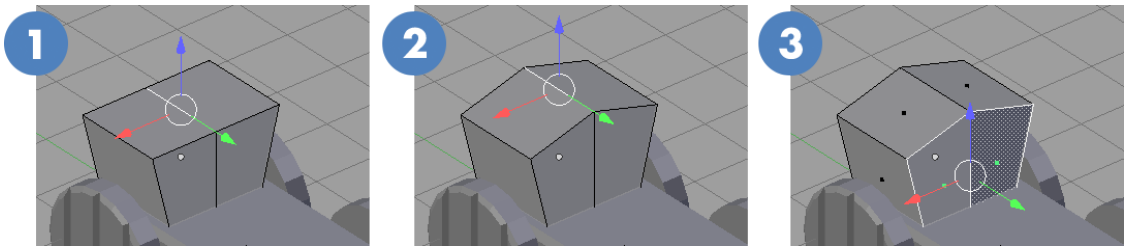
Note: Move your mouse before the second click to move your cut. Scroll the mouse wheel to create multiple cuts. Be aware that loop cuts only work with connected **quads** (faces with four edges). Modeling with only quads is good form.



Shaping the body

When you finish a Loop Cut, you'll be automatically switched to **Edge Select Mode**. This is perfect:

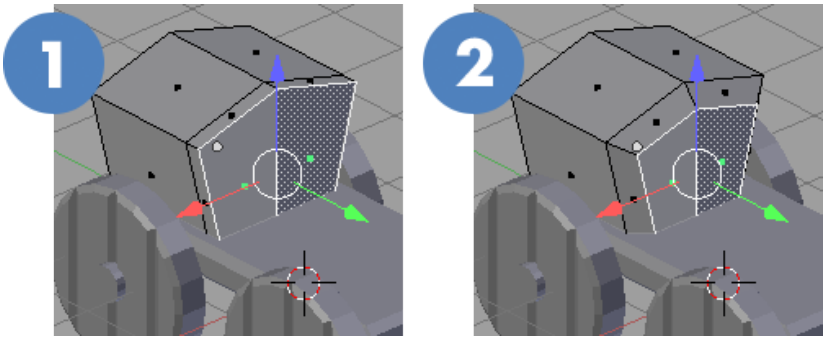
1. Click the edge in the middle, on the top.
2. Drag the blue arrow up a bit, or type **G Z 0.3**.
3. Press **Ctrl-Tab** and switch to **Face Select Mode**. Select the back two faces.



Extrude, scale, repeat

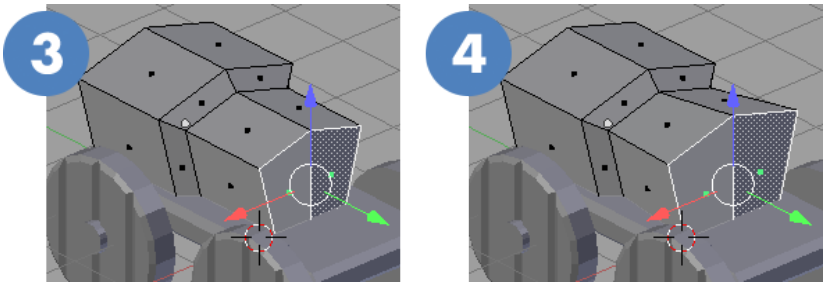
The **Extrude tool** takes your selected faces and extrudes them outward, creating new faces along the sides. This is the primary tool you'll use to create the ridged body.

1. Press **E** to extrude the selected faces. You only need a small extrusion this time, so move the mouse just a bit, then click to complete the extrusion.
2. Press **S** and drag to scale the new face down a bit.

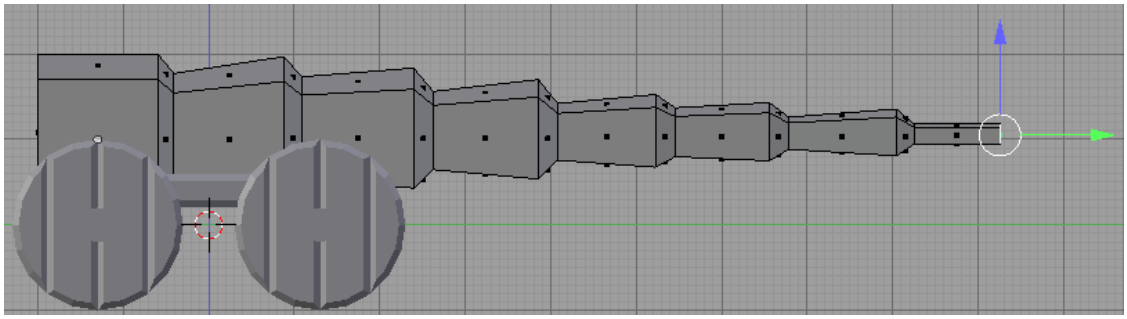


3. Press **E** again and make a larger extrusion; about the same size as the first larger segment.

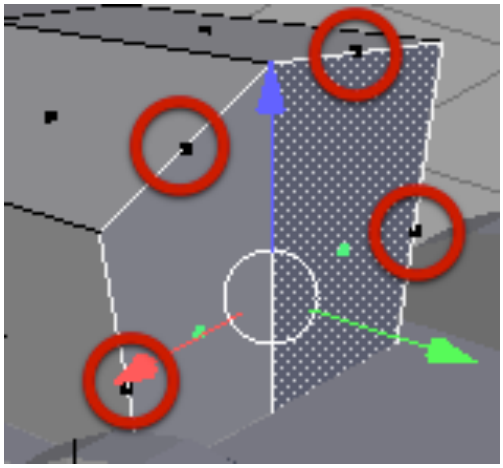
4. Press **S** and drag to make this end a bit larger.



Repeat this process until you have several segments that gradually get smaller and smaller. You might find it easier to press **3** and work in the Side View. Reminder: **Shift + middle-click + drag** to pan the view.



Note: Internally, the Extrude operation is a two-step process. It creates new faces around the edges, then moves the selection. If you start an extrusion, then cancel it with a **right-click** or **Esc** key, you are only canceling the second step. Look closely, and you will see dots along the edges that indicate a face. These extra faces could end up causing problems with your model. To cancel an extrude, press **Esc**, then press **Ctrl-Z**.

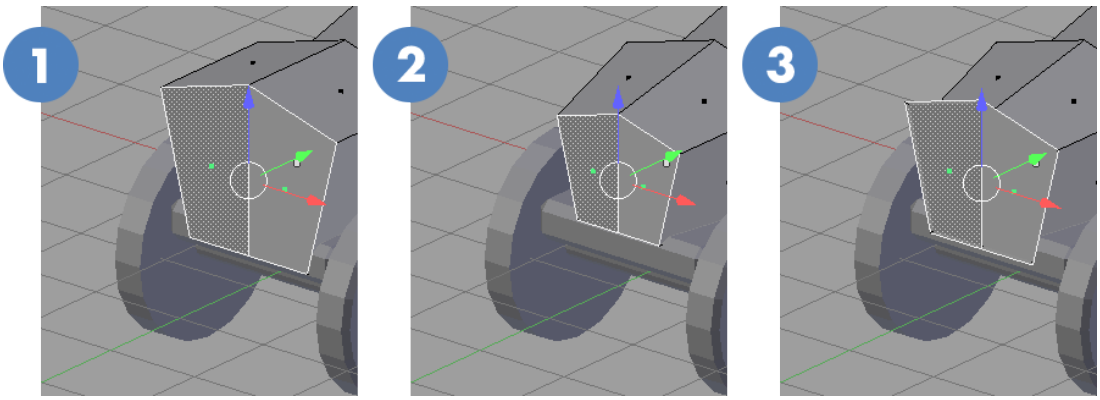


Reminder: Don't forget to save. You can find a copy of this file in the Resources folder: **Scorpion 03-Body.blend**.

Modeling the head

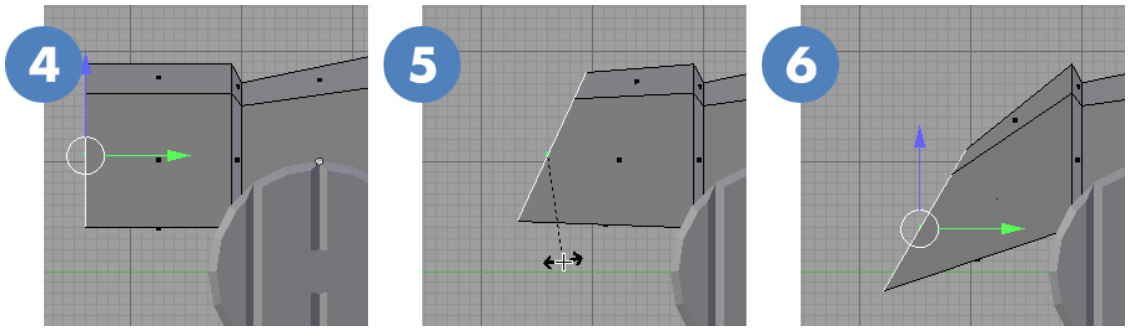
With the body out of the way, it's time to make the head!

1. **Middle-click and drag** to orbit around your model. Select the front two faces of the body mesh.
2. Press **S** and scale down these faces to give it a bit more of a neck.
3. Make a small extrusion (**E drag click**), and scale that up (**S drag click**) to form the back edge of the head.



4. Press **3** to switch to the Side View, and extrude the selection to make a shape for the head (**E drag click**).
5. Rotate the selected faces to give the head a wedge shape. Because you are in the Side View, you don't have to worry about locking the rotation to a certain axis. Simply press **R** and drag to rotate.

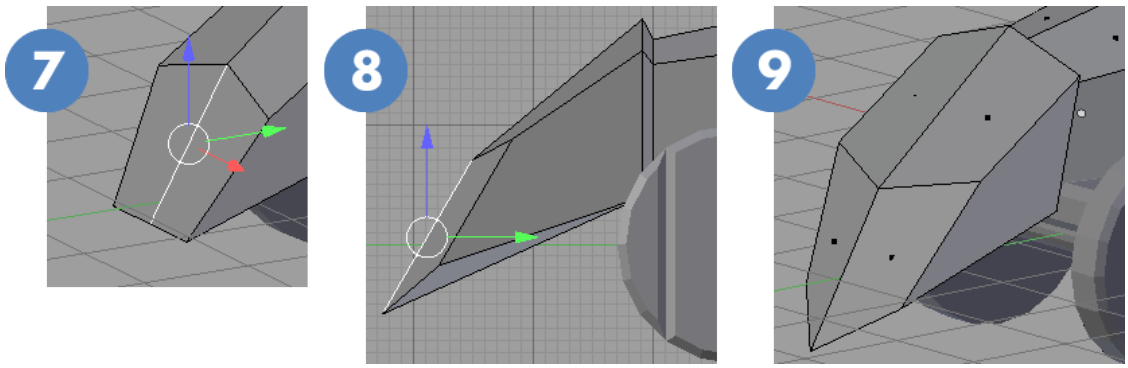
6. Move the front of the head down a bit. Again, you can move it without locking it to an axis. Press **G** and drag it into place.



7. Orbit around so you can see the front of the head. Press **Ctrl-Tab** and switch to **Edge Select Mode**. Click the edge in the middle of the head to select it.

8. Press **3** to return to the Side View. Press **G** and move the selected edge down and forward a bit.

9. Now *that* is a nice looking head! Press **Tab** to return to Object Mode.



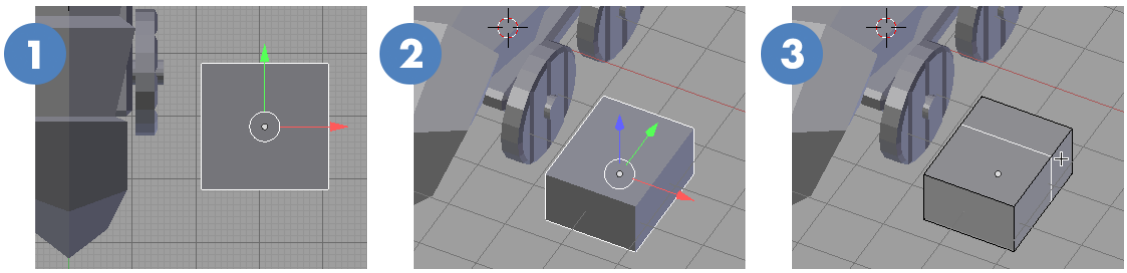
Reminder: Don't forget to save. You can find a copy of this file in the Resources folder: **Scorpion 04-Head.blend**.

Making the claws

1. Press **7** to switch to Top View. Add a new cube (**Shift-A**) and move it (**G**) out to the side.

2. Orbit to to an angled view, and press **S Z 0.5**, then **S X 0.8** to scale the cube a bit. Press **Ctrl-A** to Apply Rotation & Scale.

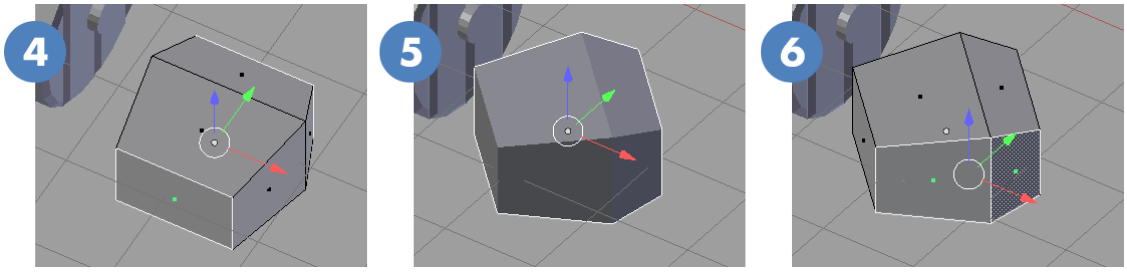
3. Press **Tab** to enter Edit Mode. Press **Ctrl-R** to create a loop cut, as shown. This time, slide the cut back a bit, instead of centering it.



4. Press **Ctrl-Tab** and switch to **Face Select Mode**. Select the front and back faces of the mesh; you'll need to orbit the view around the object to do this. Press **S 0.75** to scale them down a bit.

5. Press **Tab** to return to Object Mode. Press **R Z -45** to rotate the object.

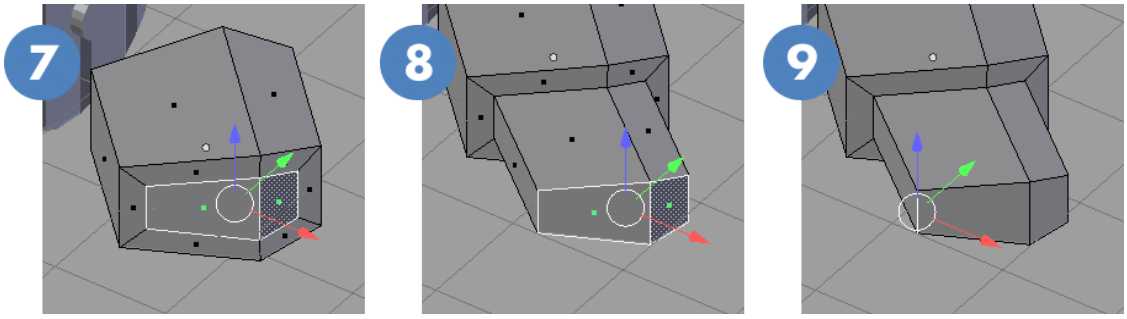
6. Press **Tab** to enter Edit Mode. Select the two faces shown here.



7. Press **I 0.2** to inset.

8. Press **E 1.2** to extrude the selection.

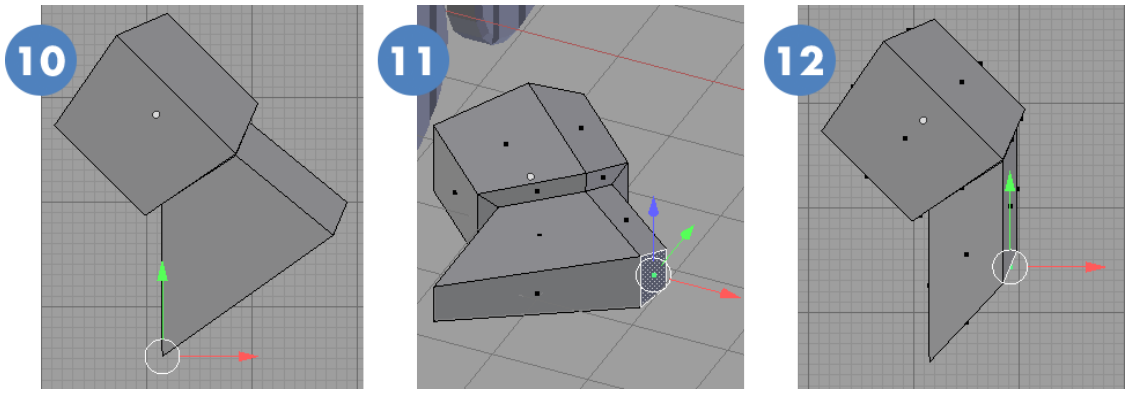
9. Press **Ctrl-Tab** to switch to **Edge Select Mode**, and select the edge shown here.



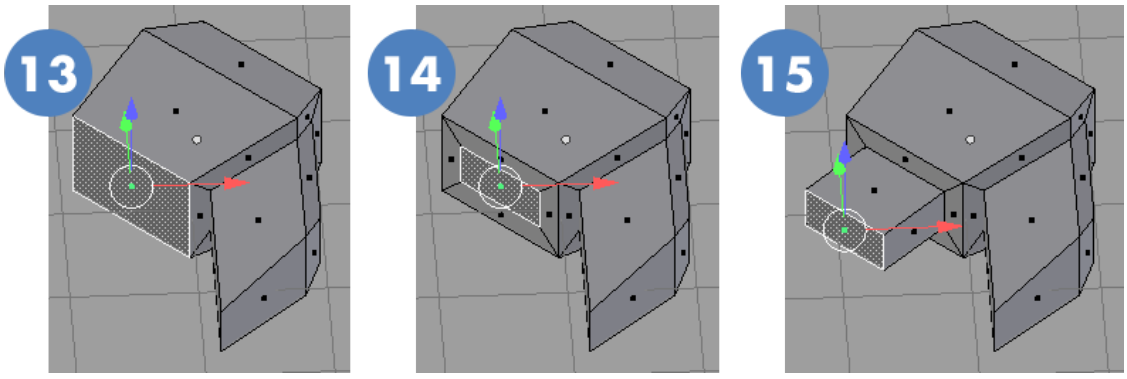
10. Press **7** to switch to Top View. Press **G** and move the selected edge as shown here.

11. Orbit around so you can see the side of the claw again. Press **Ctrl-Tab** and switch to **Face Select Mode**. Select the face shown here.

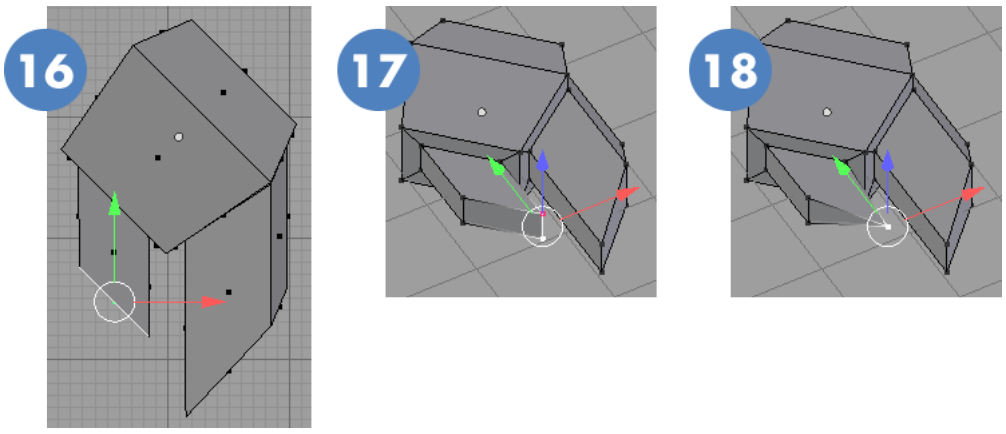
12. Press **7** to switch to Top View. Press **G** and move the selected face as shown here.



13. Orbit around to see the front of the claw. Select the face on the left.
14. Press **I 0.2** to inset this face the same as the previous inset operation.
15. Press **E 0.7** to extrude it.

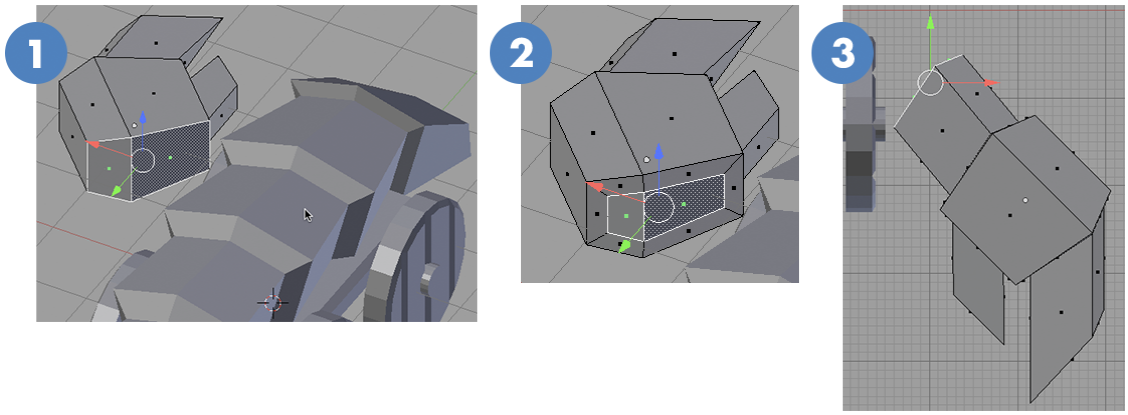


16. Press **7** to switch to Top View. Press **G** and move the selected face as shown here.
17. Orbit around so you can see the ends of both claws. Press **Ctrl-Tab** to switch to **Vertex Select Mode**, and select the vertexes shown here.
18. To merge these two points, press **Alt-M** and select **At Center**. Repeat this process for the tip of the other claw.

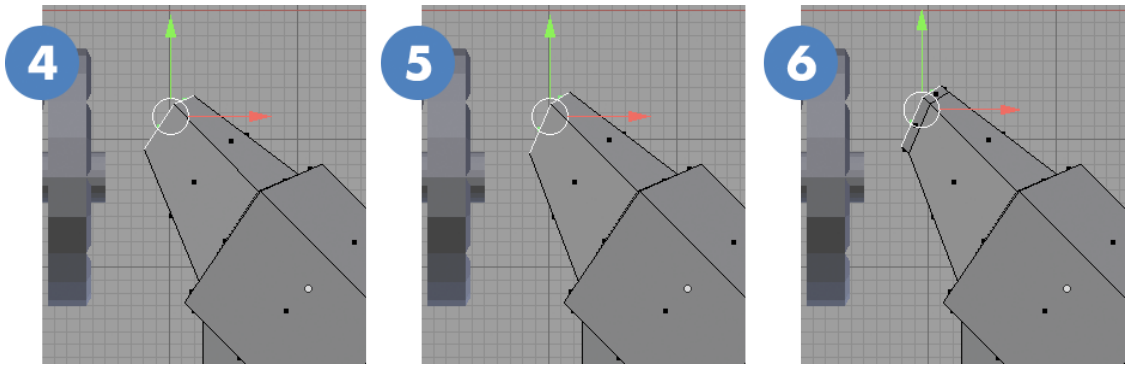


Adding the arm

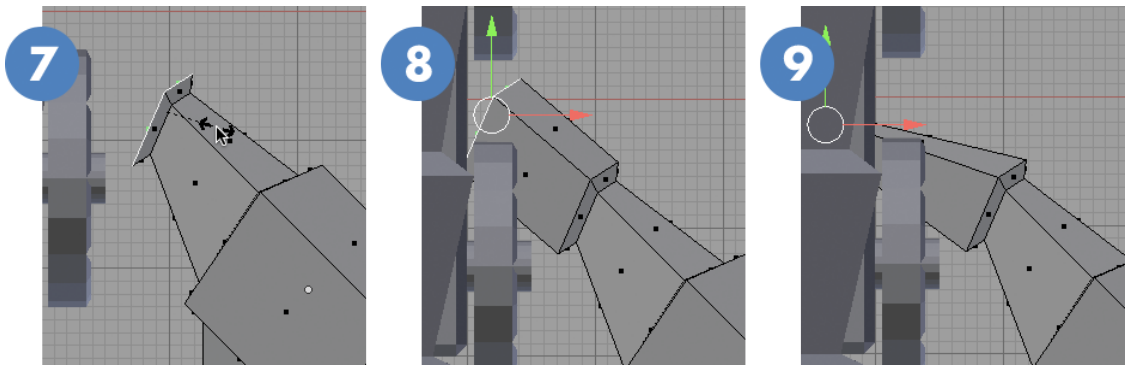
1. Orbit around so that you can see the faces shown here. Press **Ctrl-Tab** to switch to **Face Select Mode**, and select the faces shown here.
2. Press **I 0.2** to inset.
3. Press **7** to switch to Top View. Press **E 1** to extrude.



4. Press **S 0.5** to scale the selection down.
5. Ensure you're still in Top View, and press **R -10** to rotate it a bit.
6. Extrude the end a little bit (**E drag click**).



7. Scale the selection: **S 1.5**.
8. Press **E 1** to extrude the next segment.
9. Press **S 0.3** to scale down the end, then press **G** and move the end of the arm so that it's overlapping the body.



10. Press **Tab** to return to Object Mode. Orbit around to the side of the model. You can see that the arm is sticking out through the wheel!

11. Drag the blue Z Axis arrow upward until the arm is above the wheel.

Duplicate and mirror the arm

Now that you have an arm, it needs to be duplicated, and then flipped for the other side. Before you do that, have a look at the Properties Region (press **N** to toggle it). Remember when you rotated the object: Step 5 of "Making the claws". The object still has a Z-rotation value. This will interfere with the Mirror operation. Press **Ctrl-A** to Apply Rotation & Scale.

Since you're going to be duplicating objects, now is also a good time to revisit the **Outliner** at the top-right of the screen. Keep things organized by double-clicking each of your Cube objects to rename them:

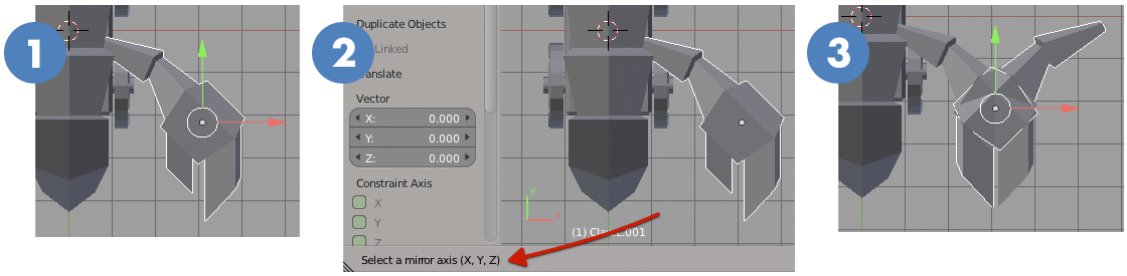
> **Note:** It's good practice to name objects with ".L" and ".R" at the end of their name, for left and right versions of mirrored objects like arms and legs.

That's better! Now it's time to duplicate the arm. Press **7** to switch to Top View.

1. Click on the arm to select it, then press **Alt-D** and immediately press **Enter** to create a linked duplicate of the object and keep it in place. Again, you use Linked Duplicate here to save time when you will color the arms in the next chapter.

2. Press **Ctrl-M** to invoke the Mirror tool. Nothing noticeable changes, but if you look at the bottom of the 3D View, you'll see that the menu bar has changed to a status bar, with the text **Select a mirror axis (X, Y, Z)**.

3. Press **X**, then **Enter** to complete the Mirror operation.

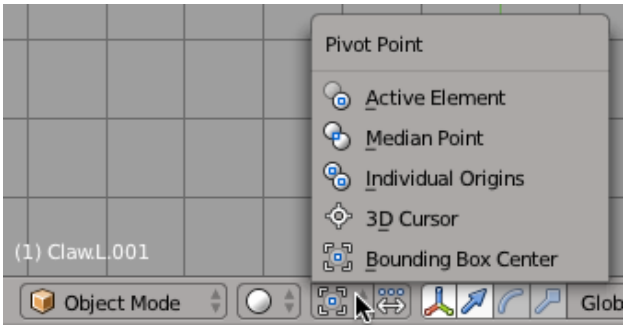


Note: The status bar shows information and options for most tools. It's a good thing to glance at while performing different tasks.

Changing the pivot point

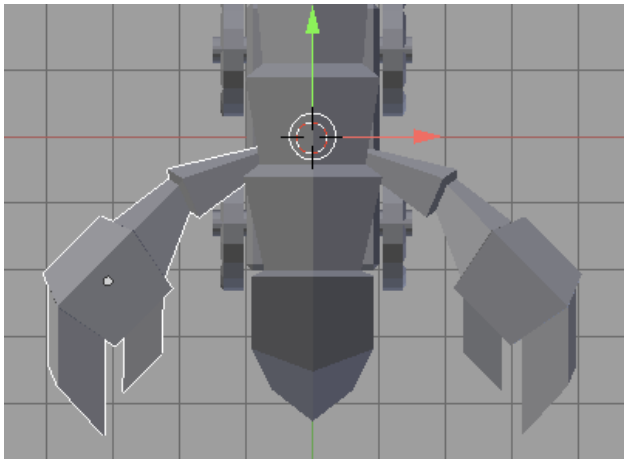
Now, this is mirrored correctly, and you *could* move the object over, but there's a way to mirror and move it in one step. Press **Ctrl-Z** to undo the Mirror operation.

Blender operations are always centered around a **Pivot Point**. So far, you have been using the default pivot point, which is the origin of the current object. There are several other options for the Pivot Point, which you can see in the menu at the bottom of the 3D View:



Change the Pivot Point to **3D Cursor**, which is at the center of the scene (remember, press **Shift-S** and select **Cursor to Center** if your cursor has been moved). Now when you mirror the arm, it will not only flip, but flip *over the cursor*.

Give it a try; press **Ctrl-M X** and press Enter to mirror over the X axis.



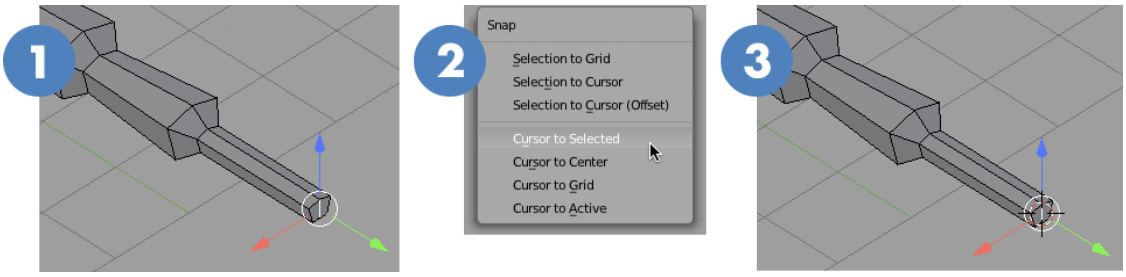
Note: Press **. (period)** to quickly switch the pivot point to **3D Cursor**. Press **, (comma)** to switch it back to **Bounding Box Center**. In this mode, the pivot point is actually the object's origin, which is not always the center of the bounding box.

Reminder: Don't forget to save. You can find a copy of this file in the Resources folder: **Scorpion 05-Arms.blend**.

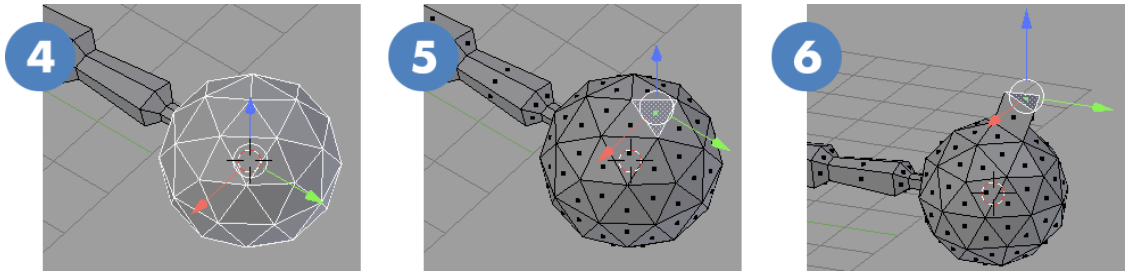
Modeling the wrecking ball

Next up: adding a sphere for the wrecking ball on the end of the tail. You learned about using the 3D Cursor as a pivot point for the Mirror tool; now use it to change where a new object is created.

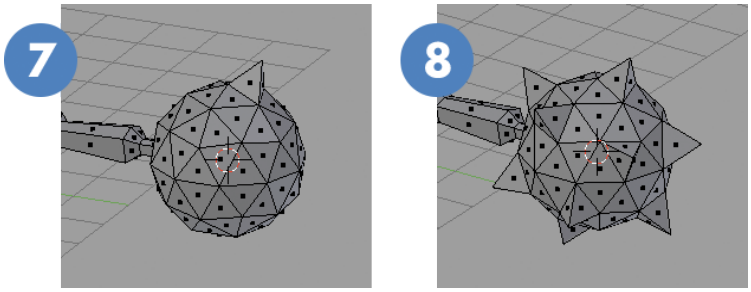
1. Orbit around your object so you can see the end of the tail. Select the body object and press **Tab** to enter Edit Mode. Press **Ctrl-Tab** and switch to **Edge Select Mode**. Select the edge in the middle, at the back.
2. Press **Shift-S** and select **Cursor to Selected**.
3. You'll see the cursor snap to the center of the current selection.



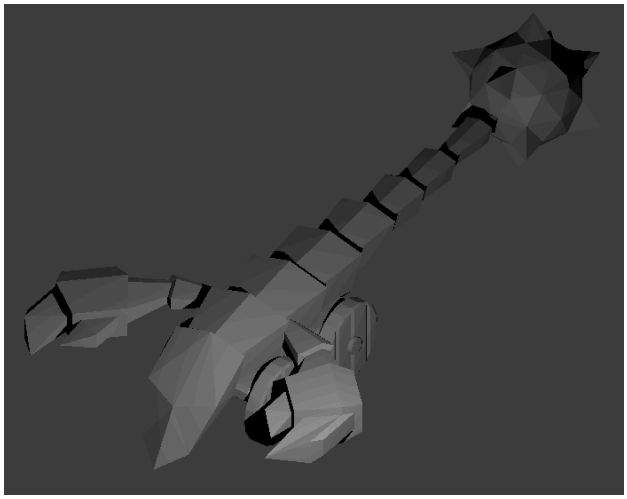
4. Press **Shift-A** and select **Icosphere**. Note that you are adding a new mesh *in Edit Mode*, which is essentially the same as creating two separate objects and combining them, as you did with the wheels and axle. This Icosphere mesh is now part of the Body object.
5. Press **Ctrl-Tab** and switch to **Face Select Mode**. Select one of the faces on the icosphere.
6. Press **E 0.6** to extrude the face.



7. Merge the three points of the selected face: press **Alt-M** and select **At Center**.
8. Repeat this process for several faces around the icosphere to create more spikes.



Press **Tab** to exit Edit Mode, and you are done! Press **Shift-Z** to toggle the view to a **Rendered** display. Looking good!



Important: When you finish a model, remember to apply all the transformations on each of your objects before moving on. Select an object in your scene, press **Ctrl-A** and select **Rotation & Scale**. Repeat this for every object.

Where to go from here?

Congratulations! You have mastered some of the mystic arts of modeling in Blender.

So far you've learned several core modeling techniques that could be used to model almost any shape you can imagine. Experiment with what you've learned, and see what other kinds of objects you can create! Hopefully you have become comfortable working with keyboard shortcuts, and can see how they enable to you model efficiently in Blender.

The following page has a list of the keyboard shortcuts you learned, to help you along the way.

In the following chapter, you will learn about UV texturing to add color your model.

Summary of keyboard commands

- **X** - Delete
- **Shift-A** - Create new objects
- **G** - Move
- **R** - Rotate
- **S** - Scale
- **K** - Knife
- **I** - Inset
- **E** - Extrude
- **Ctrl-Tab** - Mesh Selection Mode
- **Shift-D** - Duplicate
- **Alt-D** - Linked Duplicate
- **Ctrl-B** - Bevel
- **Ctrl-A** - Apply (Rotation & Scale)
- **Ctrl-R** - Loop Cut
- **Alt-M** - Merge Points
- **Ctrl-M** - Mirror
- **. (period)** - Move pivot point to 3D Cursor
- **, (comma)** - Move pivot point to current object
- **Shift-Z** - Toggle rendered view

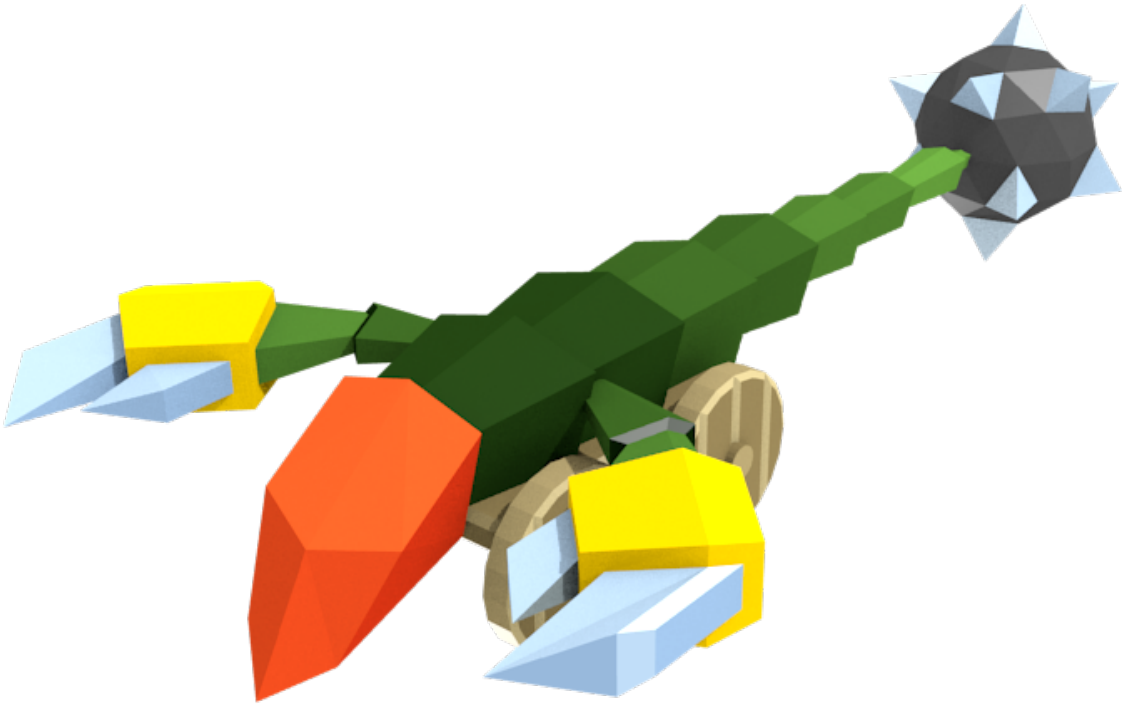
3D View controls:

- **1** - Front View
- **3** - Side View
- **7** - Top View
- **5** - Toggle perspective

Chapter 16: Texturing with Blender

By Mike Berg

In the previous chapter, you just created a sweet model with Blender, but it's a little, uh — *monochrome*. What's next? Giving it some color, of course!



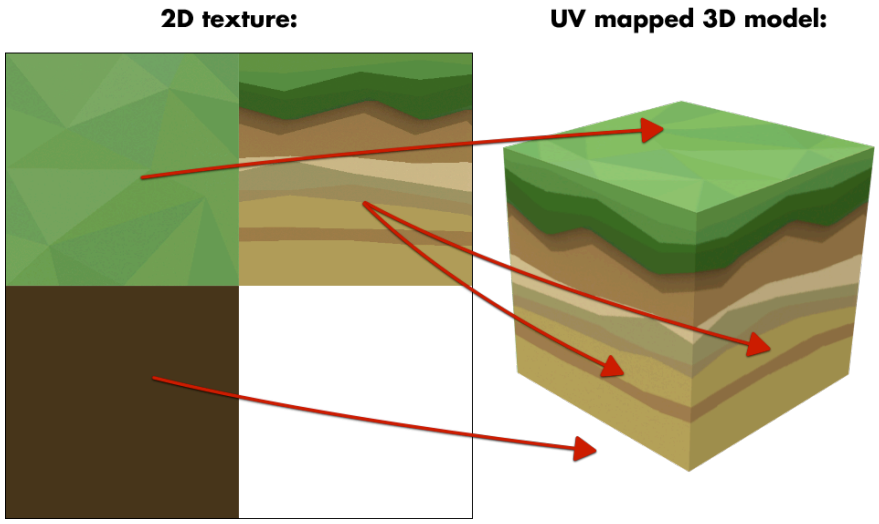
Texturing involves taking 2D artwork and applying it to 3D surfaces.

Note: This chapter builds on the skills learned and the model made in Chapter 15. I recommend you read through that chapter before this one.

Getting started

Texturing a model in Blender can be done in many different ways. You'll be covering the most common method used in video games: **UV Mapping**.

UV Mapping allows you to take each face in your mesh, and "project" part of a 2D image onto it. Typically, this is done by "unwrapping" the mesh so that it can be "laid flat", and arranged onto a 2D image.



In the above example, each face of a simple cube is mapped to different areas of a single image. Note that UV mapping allows for any area of a texture to be used for multiple faces; in this case, all four sides use the same part of the texture.

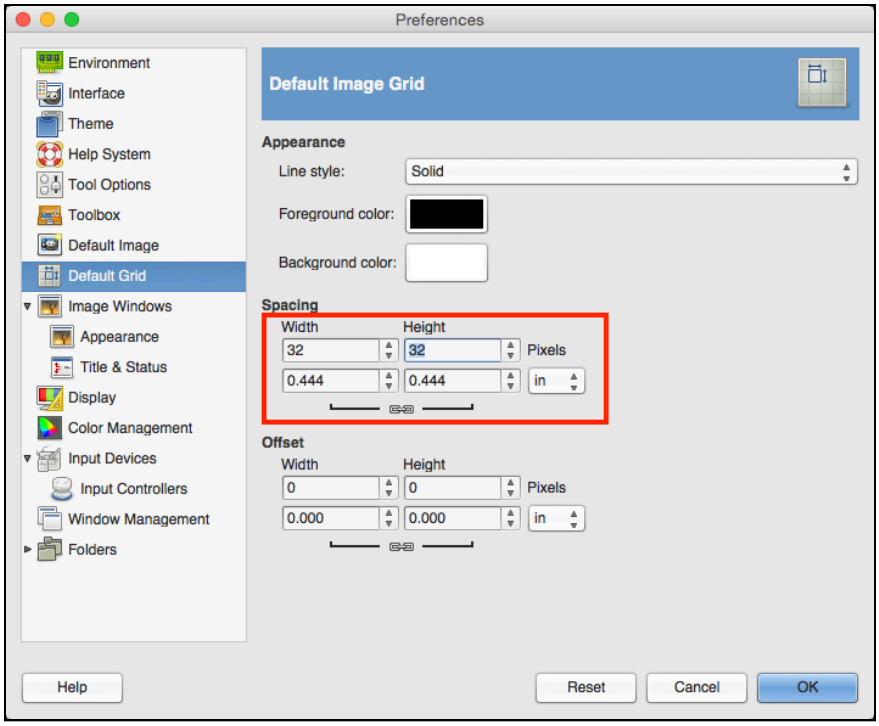
To create your 2D texture, you need an image editor. You could use Photoshop, but GIMP is a great alternative. GIMP is an open source image editor that works on all platforms. It's free and it is feature packed. The only thing it truly lacks is a good name, but you can't have everything! :]

The instructions below are for GIMP, but you can use any image editor of your choice. Start by downloading GIMP for Windows, Mac or Linux:

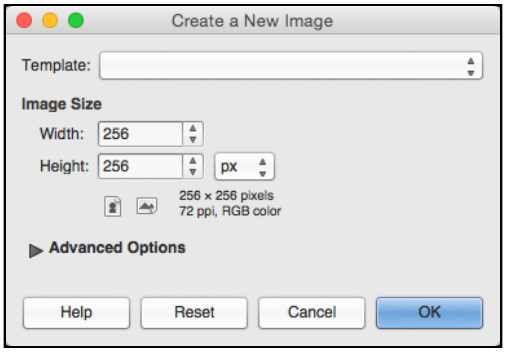
http://www.gimp.org/downloads/

Creating a texture

Launch GIMP. Before you create a new document, set the grid, to make it easier to work with. From the menu bar, select **GIMP\Preferences**. Click **Default Grid**, on the left, and change the **Spacing** to 32×32:



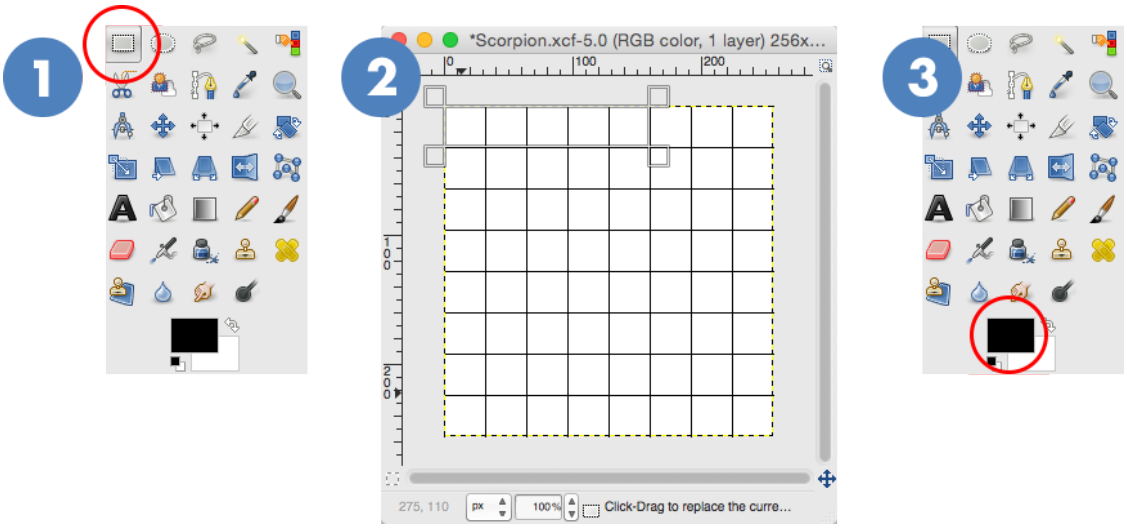
Click **OK**, then select **File\New**. It's good practice to make your texture sizes "power of 2"; 128×128, 256×256, 512×512, and so on. Because we're going to be working with flat colors, we don't need a very big texture; set your new document to 256×256:



Select **View\Show Grid**, then **View\Snap to Grid**. Before you go any further, select **File\Save As** and save your document into the same folder as your 3D model.

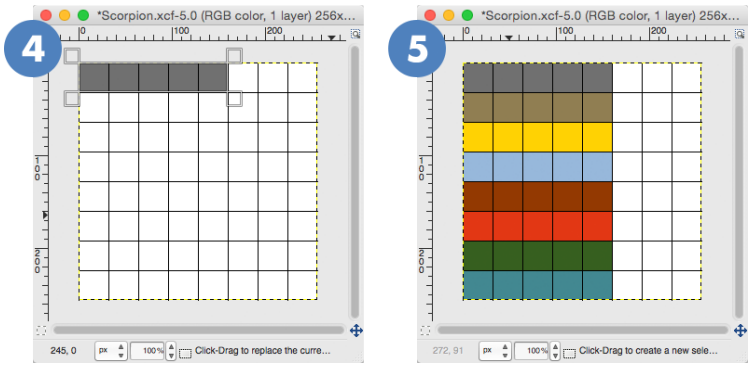
You need some solid, flat colors to use for your model. You can use whatever colors you like, and you'll learn a simple trick for getting some variations on each base color.

1. Start by clicking the **Rectangle Select** tool from the toolbar.
2. Make a selection at the top-left of the document that is 5 grid-squares wide.
3. Click the **Foreground Color** in the toolbar to pick a color.



Use the color picker to select one of the colors you want to use on your model. I started with a grey. Enter **707070** in the **HTML notation** field to use the same color, and click **OK**.

4. Select **Edit\Fill with FG Color** (**Cmd-,**) to fill the selection with the foreground color.
5. Drag the selection down one grid space and select a new color, repeating the process for several colors.



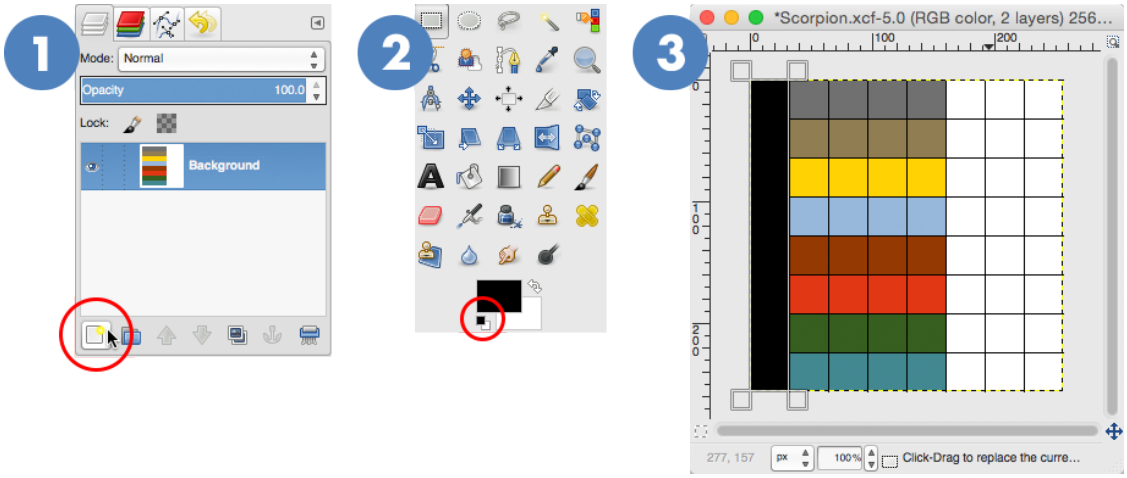
If you want to use the same colors, here are their values: `707070`, `907e52`, `ffd200`, `97b8db`, `933900`, `e23715`, `375f1f`, `438891`.

Select **Select\None** (**Cmd-Shift-A**).

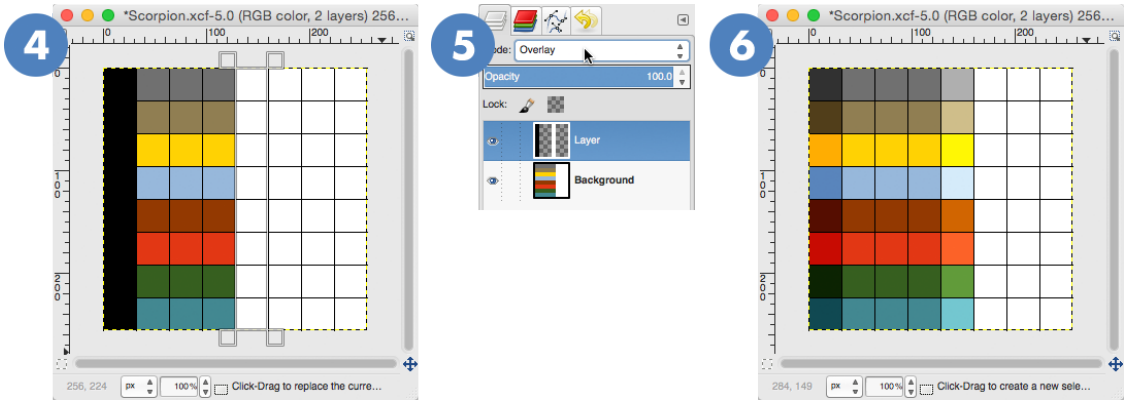
Adding shading

While you certainly may want to hand-pick each color, there's a simple trick for adding darker and lighter versions of all of these colors at once — in just a few steps.

1. In the **Layers Palette**, click the **New Layer** button and click **OK** on the resulting dialog to create a new layer.
2. Click the tiny **Foreground/Background** icon in the Tools palette to reset the colors to black and white.
3. Use the **Rectangle Select** tool to select the left-most column in the grid, and press **Cmd-,** to fill it with black.



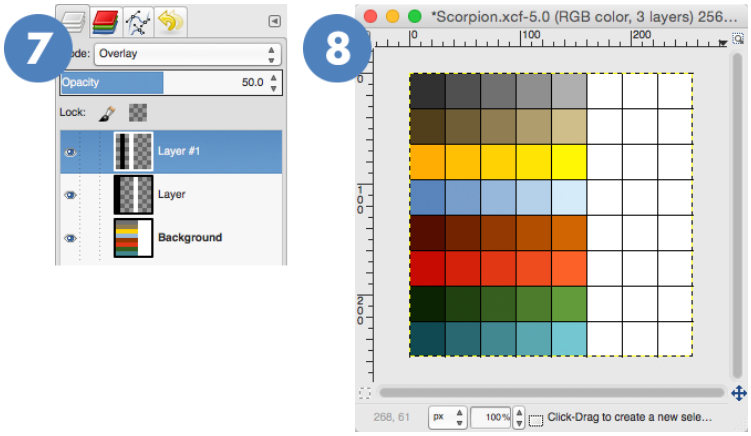
4. Use the **Rectangle Select** tool to select the right-most column in the grid, and press **Cmd-.** to fill it with white.
5. In the **Layers Palette**, change the **Mode** popup to **Overlay**.
6. Your left-most column is now nicely shaded, and your right-most column has a nice highlight.



Create another new layer and repeat this process, but this time select the second column and fill it with black. Then select the fourth column and fill it with white.

7. After setting the **Mode** to **Overlay**, set the **Opacity** to **50%**. The opacity setting can be found directly underneath Mode field.

8. Now you have a nice range of colors to work with, and some variation in shading.



Select **File\Export** and save the PNG into the same folder as your Blender file.

Let's get those colors on your model!

Creating the Material in Blender

When texturing a model in Blender, there are two tabs in the **Properties** panel that you'll need to use: **Material** and **Texture**.

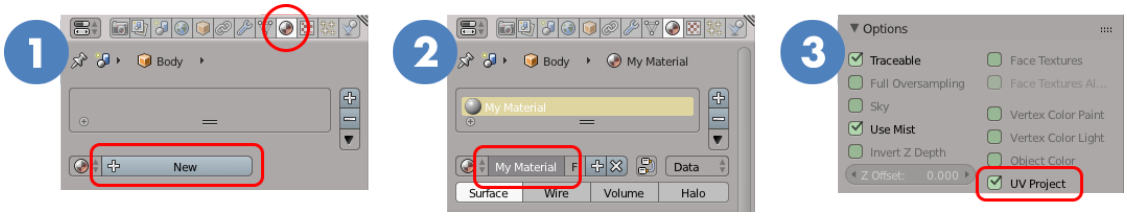
The Material tab

Open your scorpion model or you can open the scorpion starter project included with the resources. Make sure you are in **Object Mode**.

1. Click the body of your model to select it. In the **Properties** panel on the right, click the **Material** tab, then click the **New** button.

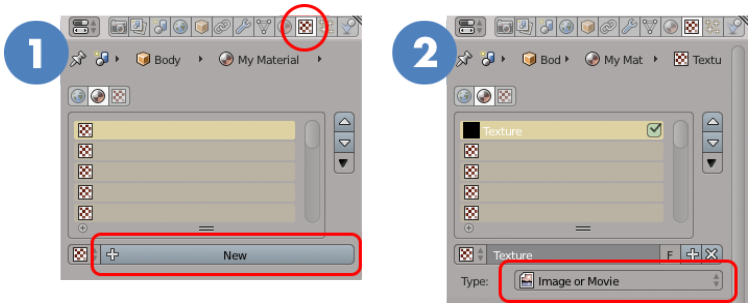
2. It's good to get into the habit of naming your material. Do that here.

3. Scroll down to the **Options** section, and select **UV Project**.



The Texture tab

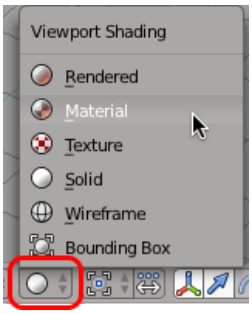
1. In the Properties panel, click the **Texture** tab, then click the **New** button. More options will appear.
2. Ensure that the **Type** popup is set to **Image or Movie**.



3. Scroll down to **Image** and click **Open**. Select the PNG you just created.
4. Scroll down to **Mapping**, set the **Coordinates** popup to **UV**.

Configuring lighting in your scene

In the **3D View**, switch the **Viewport Shading** to **Material**. This will let you see the material colors you apply, right in the main view.



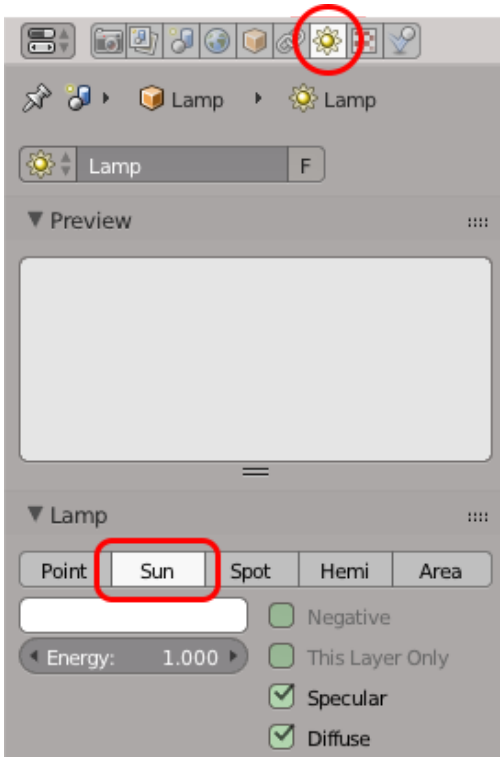
Not much changes, because you haven't UV mapped your model yet. But notice that with the default lighting in a Blender scene, it can be hard to see your model from all angles.

Orbit around to the bottom of the model and it looks almost completely black. When adding color to your model, you want to be able to see it from any angle.

Select the light in your scene. It looks like this:

> **Note:** You can also select it by clicking the **Lamp** object in the Outliner, at the top-right of your screen.

In the **Properties** panel, click the **Object Data** tab and in the **Lamp** section, change it from **Point** to **Sun**.



This removes falloff, where the light gets dimmer as you get farther from it, and makes the light "parallel", where everything in your scene will be lit the same amount, and from the same angle.

> **Note:** The position of a **Sun** light is irrelevant. Only the rotation angle matters, which is indicated by the dotted line coming out of the light.

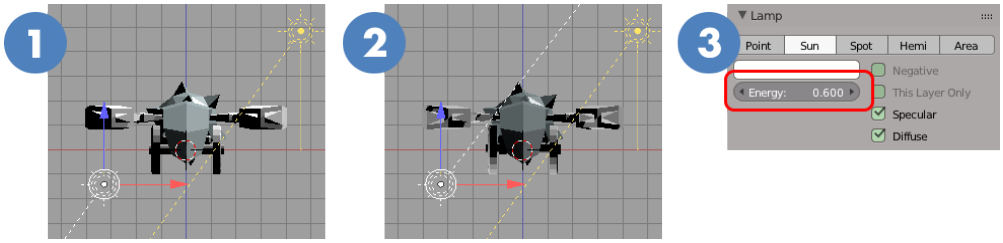
Your model is now much brighter, but it's still dark on one side. To solve this, create a **fill light**:

1. Press **1** to switch to front view. Duplicate the light (**Shift-D**) and move the copy down and to the left.

I know I just said the position doesn't matter, but they will be easier to select if they are not in *exactly* the same place.

2. Press **R** and rotate the angle of the light so that it is pointing in the opposite direction as the first light.

3. In the **Properties** panel, change the **Energy** to **0.6**.



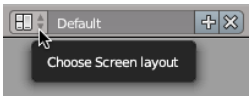
Orbit around your model, and you'll see that it's nicely lit up no matter which angle you're looking from.

UV Mapping your model

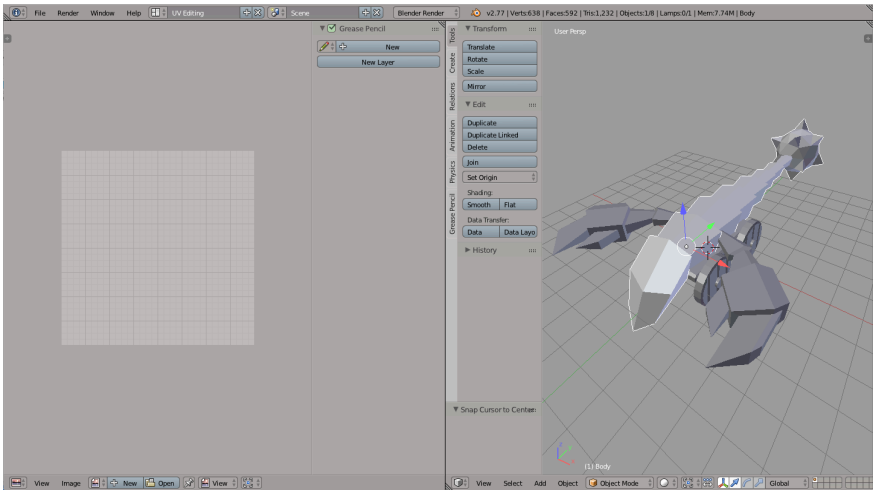
Now that you've got your material, texture and lighting set up, it's time to map the texture to the model!

Setting up your workspace

At the top of the Blender window, Switch to the **UV Editing** workspace.

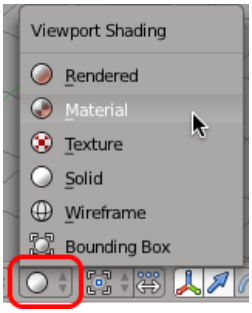


The screen layout now shows two panels, the **UV/Image Editor** on the left, and the **3D View** on the right.



> **Tip:** Move your cursor over the 3D View and press **T** to toggle the Tools panel. With your cursor over the UV/Image Editor, press **N** to toggle the Properties panel. That gives you a bit more screen real estate to work with.

The **Viewport Shading** mode in the UV Editing workspace is controlled independently to the Default workspace, so switch this to **Material** also.

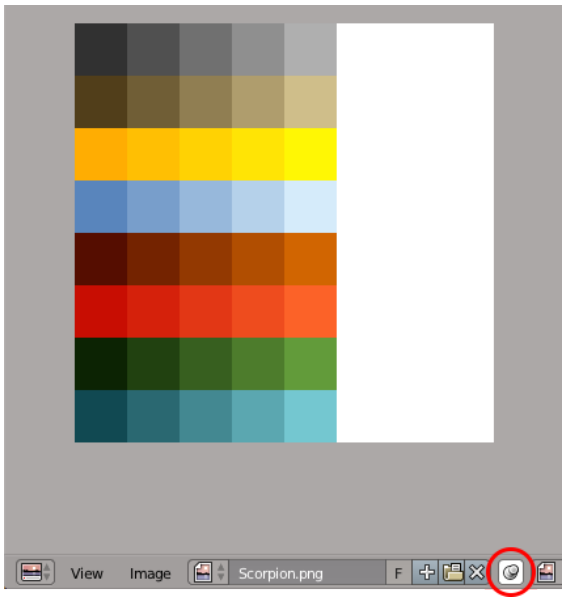


Remember, this will let you see the material colors applied to your model.

Opening the 2D texture

At the bottom of the **UV/Image Editor** panel on the left, click the **Open** button. Open the PNG you made.

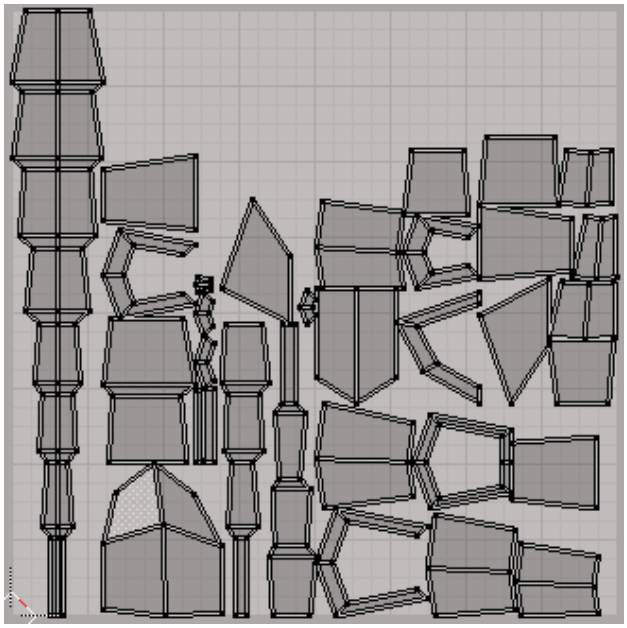
Click the **Pin** button at the bottom to prevent Blender from switching away from this image when you select a different object in the **3D View**. You only have one texture for all your objects, so you only want to see that texture.



The UV Mapping tool

Now you're ready to "unwrap" your model!

Models are 3D, but each polygon that makes it is actually flat. UV Mapping allows you to "unfold" your model and lay it flat on a 2D texture. If you were doing a hand-painted texture, you'd arrange the faces of your model onto your texture, then paint the texture in your image editor of choice:

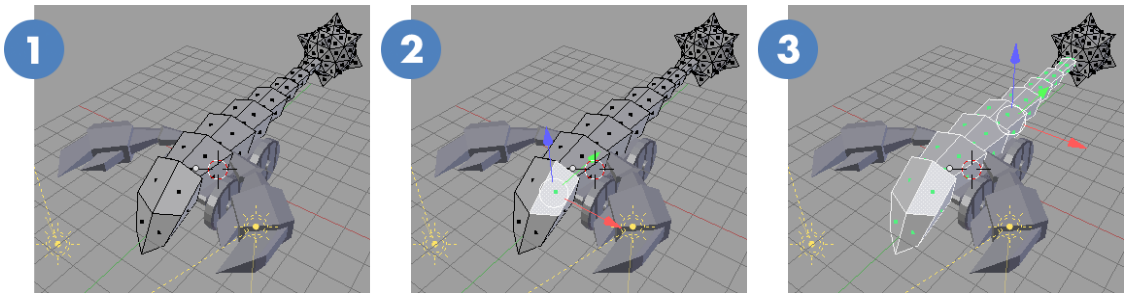


However, this model will be "flat shaded", where each face has a single, flat color. This greatly simplifies things for your UV map.

1. In the 3D View, select the **Body** object. Press **Tab** to switch to Edit Mode. Make sure you are in **Face Select Mode** (**Ctrl-Tab**).

2. Start by selecting the faces that make up the body. Pressing **A** for **Select All** doesn't work, since you don't want the spiked ball included. Press **A** to **Select None**, then select one face on the body.

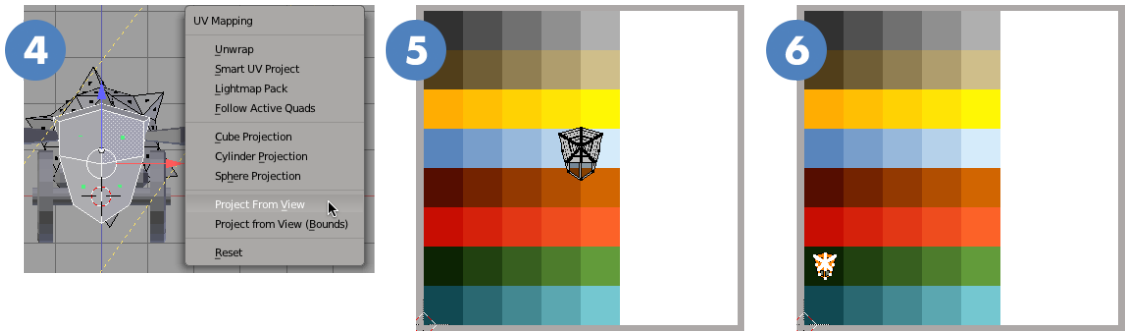
3. Press **L** to **Select Linked**. This selects everything that's attached to the current selection. When you have multiple meshes combined into a single object, this is an *essential* shortcut for selecting them.



4. Press **1**, then **5** to switch to Front View, no perspective. Press **U** and select **Project From View**.

5. Imagine the mesh getting squashed flat. The flattened mesh is projected onto the image in the **UV/Image Editor** panel on the left.

6. Move the cursor over the **UV/Image Editor** panel and use the same shortcuts for moving and scaling as the 3D View: **G** to move and **S** to scale. Scale it down so that the entire thing fits onto one of the colored squares, then move it onto the darkest green square.

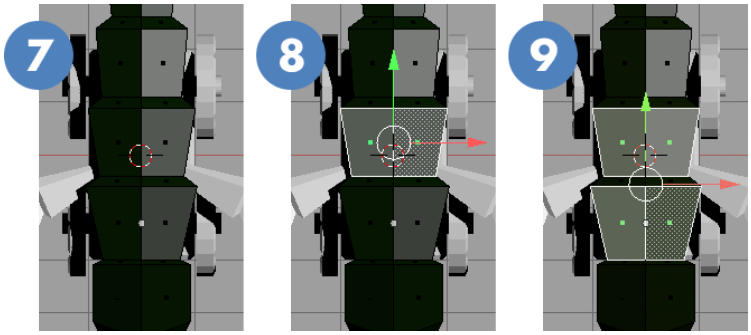


Great! You've got some color on your mesh. But it's a little plain. You can use some of the shaded color variations you made to liven things up a bit.

7. With your cursor in the 3D View, press **7** to switch to Top View. To make the separate segments a slightly different color, you need to select a *loop* of connected faces, that encircle the body. To do this, hold the **Alt** key and click the edge shown directly under the 3D Cursor, here.

8. **Alt-click** performs a **Loop Select** operation. When in Face Select Mode, it selects the quads on either side of the edge, and all connected faces all the way around the model (as long as they are quads). Orbit around your model to verify which faces are selected.

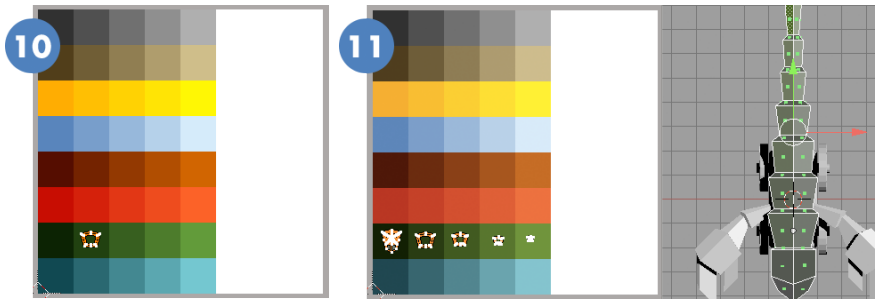
9. Press **7** to return to Top View. **Shift-Alt-click** the segment just forward of the one you have selected, to add it to the selection.



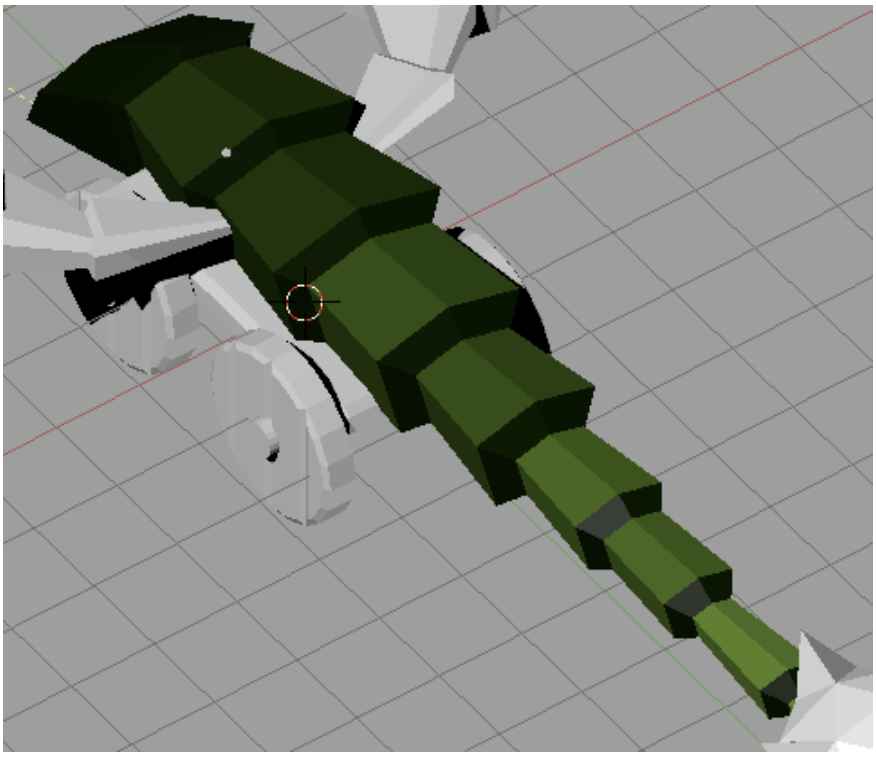
10. The faces you select in the 3D View are now selected in the UV/Image Editor panel. No need to scale them this time! With your cursor in the UV/Image Editor

panel, just press **G** to grab them and move them over one square, to the next-lightest shade of green.

11. Repeat the process for each set of two segments, leaving the smaller "folded inward" parts of the model dark. When finished, press **L** to select the whole body again. Your UV Map should look something like this.



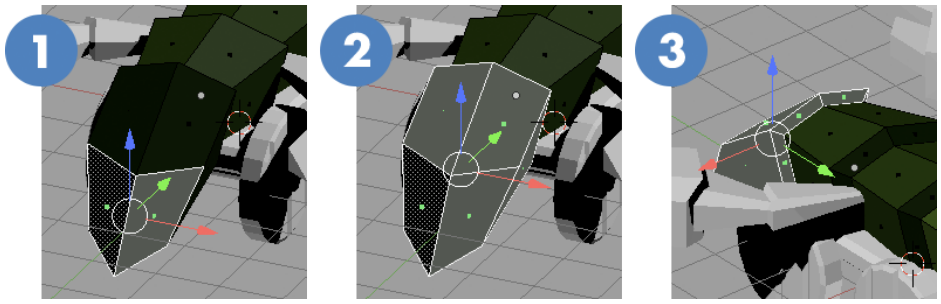
Now the body color has a bit of variation, with some definition along the ridges in each segment.



Coloring the head

1. Orbit around to the front, and select the frontmost two faces.
2. Rather than manually selecting each face for the head, use the **Select More/Less** feature. Press **Ctrl + (plus)** to "select more". The faces attached to the current selection are now selected.

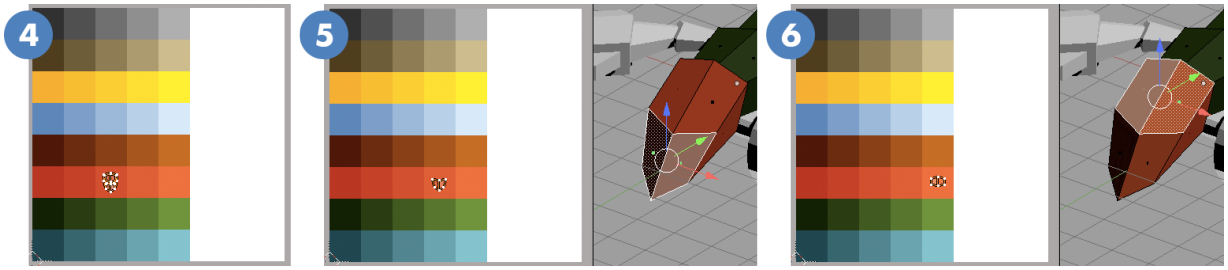
3. Orbit around to see the back of the head and press **Ctrl + (plus)** once more. Now all the faces of the head are selected.



4. In the UV/Image Editor panel, press **G** and move the selected faces to the mid-tone red square.

5. In the 3D View, press **A** to Select None. Reselect the frontmost two faces again, and in the UV/Image Editor panel, move them one color box to the right.

6. Select the top two faces and move their UV coordinates to the lightest red box.



Assigning the material to each object

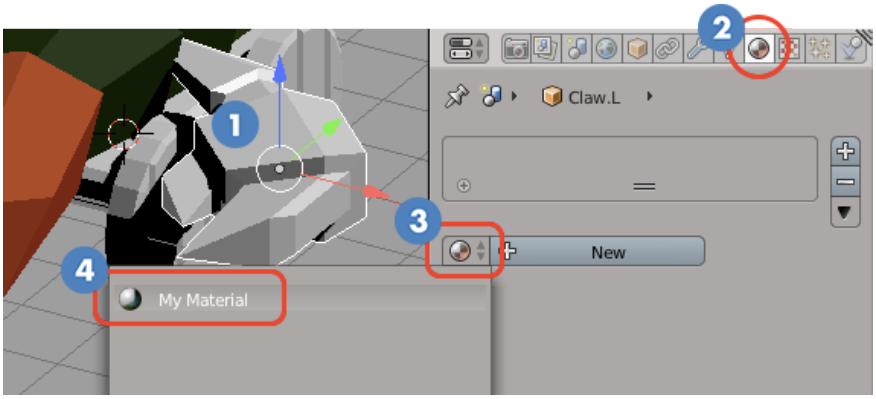
You're getting the hang of it! To color other objects, you need to assign the material to each one. Use the **Screen Layout** popup at the top of the screen to switch back to the **Default** layout. Press **Tab** to switch back to Object Mode.

1. Click one of the arms to select it.

2. In the **Properties** panel, select the **Material** tab.

3. Click the small **Material popup** beside the **New** button.

4. Select the material you created from the popup, to assign it to the Arm object.

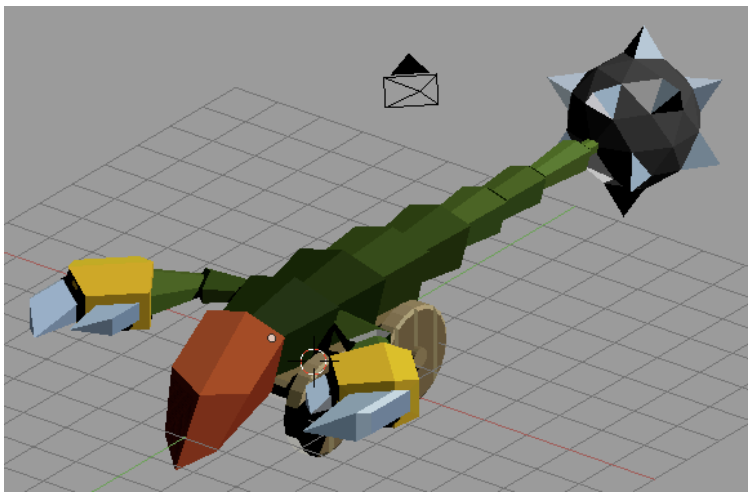


Repeat this process for each of the objects in your scene, to ensure all your objects have the material assigned to them.

Coloring the rest of the model

Switch the Screen Layout back to **UV Editing**, and you're ready to UV map the rest of the model.

1. Select the object.
2. Press **Tab** to enter Edit Mode. Press **Ctrl-Tab** and ensure you are in **Face Select Mode**.
3. Select the faces you want to map. **Alt-click** an edge to **Loop Select**. Press **L** to select all connected faces/ This will be useful for the spiked ball on the tail, the axels, and wheels.
4. Press **U** and select **Project from View** to project the mesh onto the UV map.
5. In the UV/Image Editor panel, scale and position the mesh onto a color box.
6. In the 3D View, press **A** to Select None, then select some of the faces to add some color variation.



Note: Because you used **Linked Duplicate** when we duplicated the axles and arms in the previous chapter, you only had to UV map one. The second object shares the same mesh, and therefore the UV map, too.

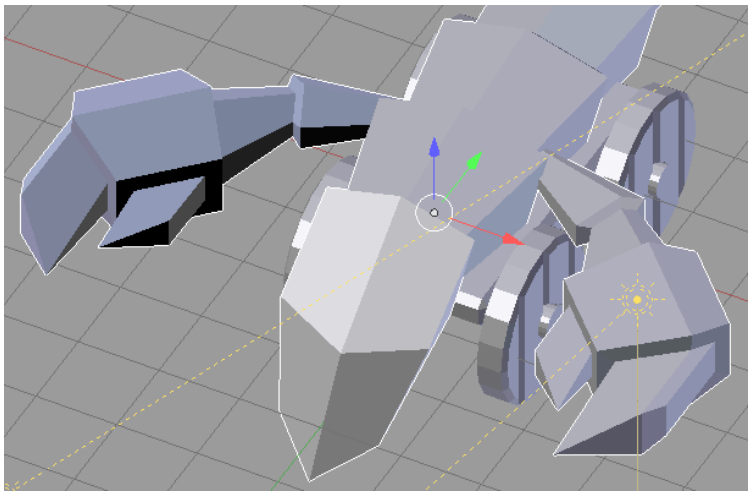
Joining the body parts

Now that the arms are UV mapped, you can **join** them with the body object. If you had joined them *before* UV mapping them, you'd have to UV map each one separately.

Joining these three objects will help in the next chapter, when you'll be animating the entire body. It's easiest if the meshes you are animating are all in one object.

Select one of the arms, then Shift-select the other arm; Shift-select the body last. The order of selection matters! The last object selected is the one that the other objects are merged into, and it is the one that keeps its origin point.

Press **Ctrl-J** to Join the three objects.



A sneaky, hidden problem

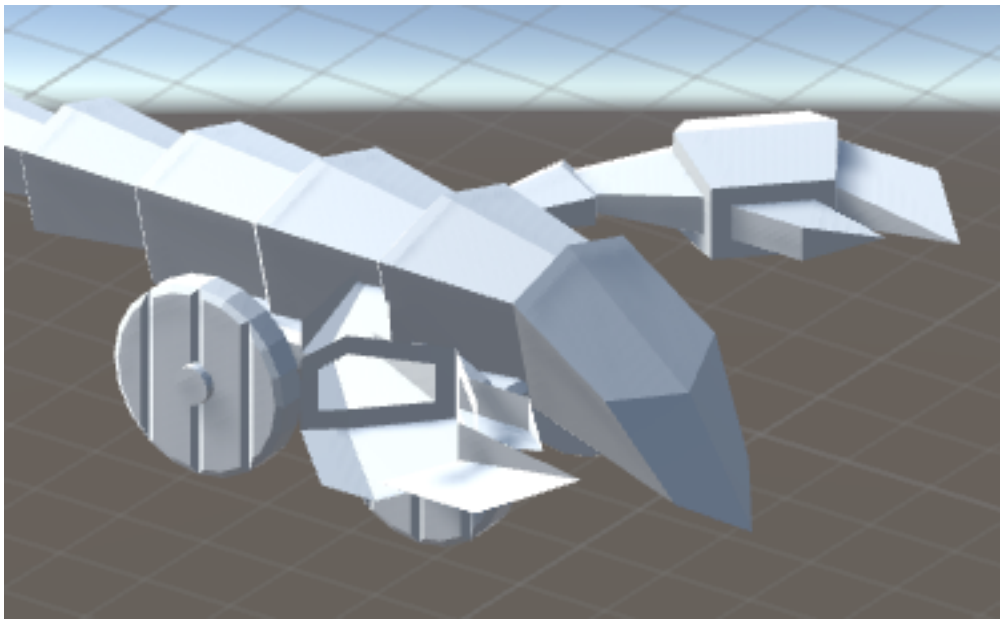
Something has happened here that is not obvious, but *will* cause problems later on.

Switch the **Viewport Shading** to **Solid** to see one indication of the problem. See how the arm that was flipped is a darker grey?

When you flipped the object, Blender did so by using a scale transformation for the X axis of -1. When that object was joined with other objects that did not have that scale factor, that flipped the *faces* inside out.

In a game engine, a polygon will only display when you look at it from one side. The direction a polygon is facing is called its **Normal**. When the geometry was mirrored, the normals got flipped, too.

This is an easy one to miss because it's not always immediately obvious — until you get the model into Unity, where it looks like this:

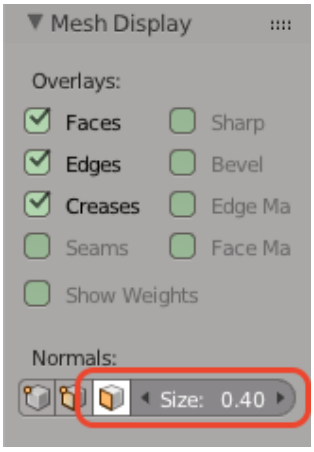


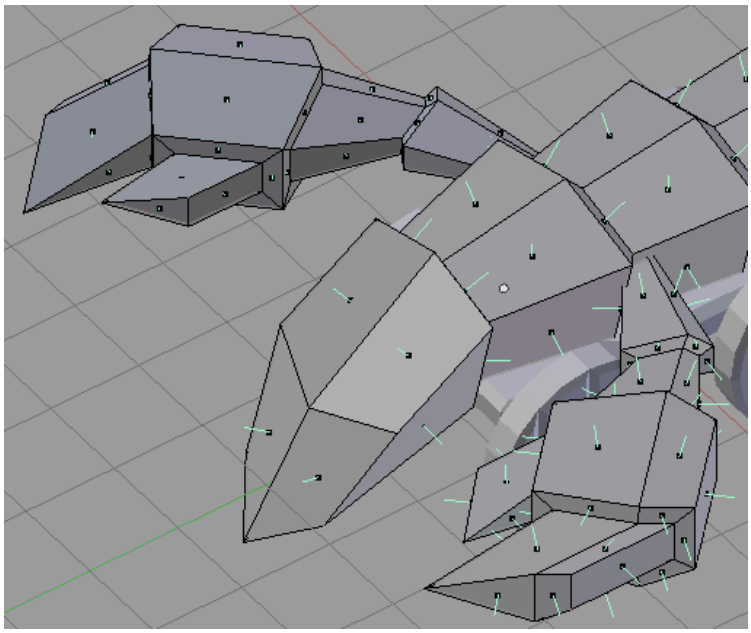
It's a bit hard to see unless you can actually rotate around it, but what you're seeing here is the *inside* of the mesh faces on that arm.

Back in Blender, there's an easy way to check the normals on a model.

In the 3D View, press **Tab** to enter Edit Mode, then press **N** to toggle the Properties shelf, if it's not already open.

Scroll down to the **Mesh Display** section, and click the **Display face normals as lines** button. Increase the **Size** to 0.4, to make the lines more noticeable.





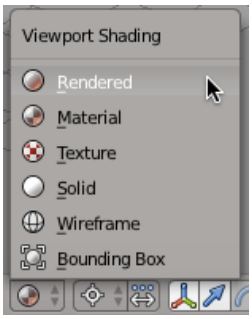
As you can see, toggling the display of the face normals makes it easy to tell which ones are facing the right way.

Fortunately, it's easy to fix. Select one of the culprit faces and press **L** to Select Linked. In the menu bar at the bottom of the 3D View, select **Mesh\Normals\Flip Normals**. Press **Tab** to return to Object Mode.

> **Reminder:** Don't forget to save (**Ctrl-S**).

Rendering your model

Your model is really starting to shine. To get an even better look at it, change the **Viewport Shading** popup to **Rendered**.

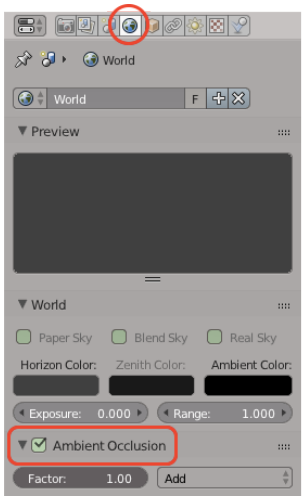


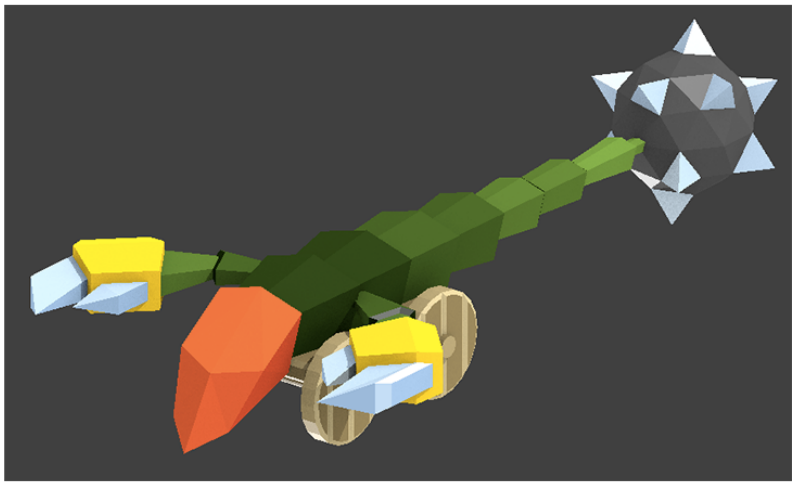
Tip: Press **Shift-Z** to toggle **Viewport Shading** to **Rendered**; press it again and the shading will revert to **Solid**. Use the popup to set it back to **Material**, if you still want to see your colors.

Ambient occlusion

Your render looks nice, but there's a quick way to make it look even better. In the **Screen Layouts** popup at the top, make sure you are in the **Default** layout.

1. While in **Rendered** view, go to the **Properties** panel and click the **World** tab.
2. Scroll down and check the **Ambient Occlusion** checkbox. Much nicer!

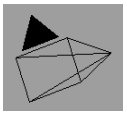




Ambient occlusion does a much better job of calculating ambient light and shadows in a scene, and will almost always make your renders look better. Simple and effective!

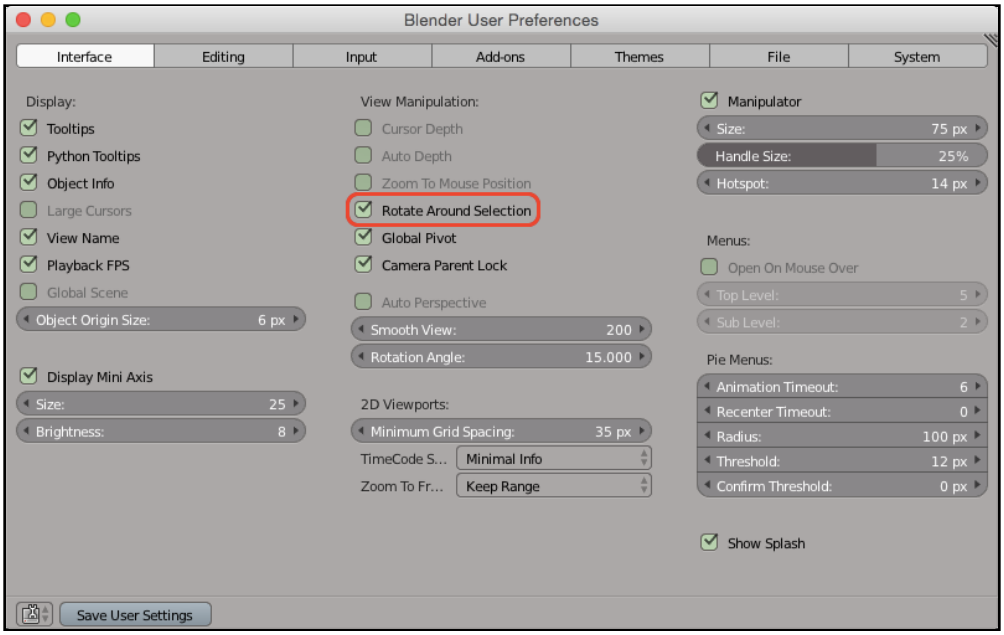
Exporting a rendered image

Unless a simple screenshot is good enough for you, you'll want to save a rendered image. To do that, you need to work with Blender's camera to fully set up a render. You've probably noticed the camera in the scene; it looks like this:

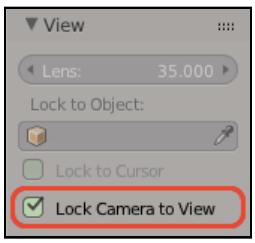


Adjusting the camera angle

Before you start adjusting the camera itself, there's one setting that will make things easier. Select **File\User Preferences** and click the **Interface** tab at the top. Select the **Rotate Around Selection** checkbox, then click **Save User Settings**, and close the window:



Back in the 3D View, press **0 (zero)** to switch to the Camera's view. Note that if you orbit or zoom the view, it jumps out of the Camera view. To control the camera's position with the regular view controls, press **N** to open the Properties panel. Under **View**, select **Lock Camera to View**.



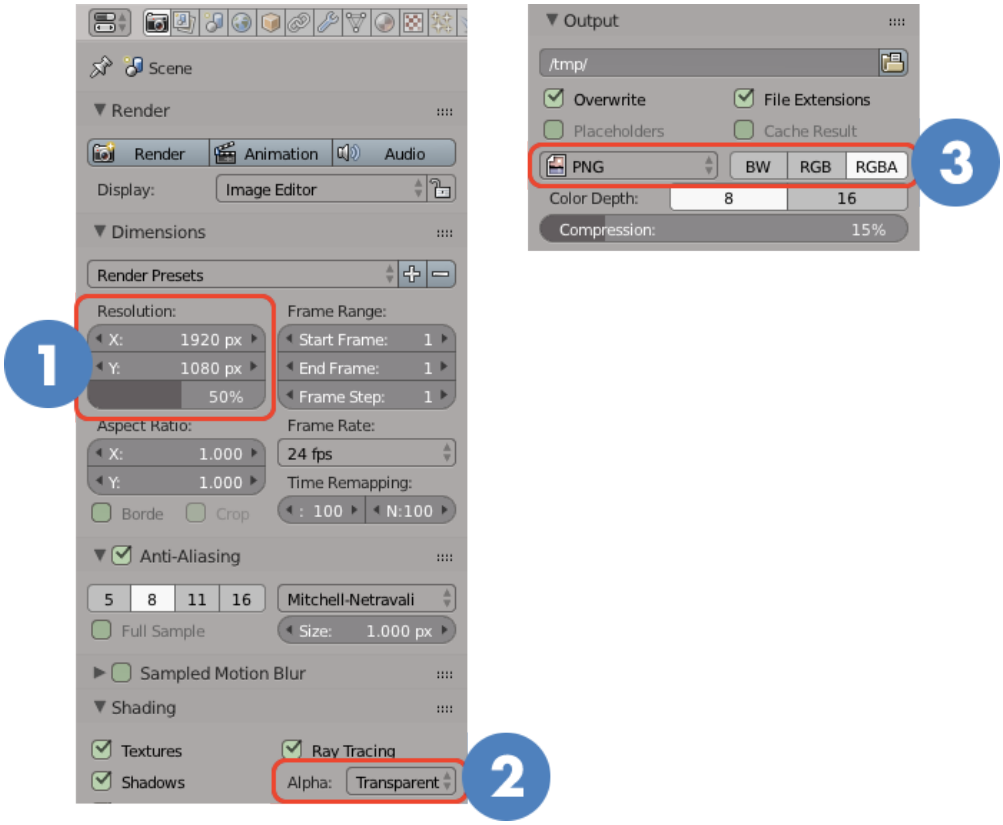
Select the body object in the scene, so that the **Rotate Around Selection** feature knows what to rotate around. Now when you orbit (**Middle-click and drag**), pan (**Shift-middle-click and drag**) or zoom (**scroll wheel**), the camera moves right along with you.

Adjust the camera angle until you have a nice view of your model.

Adjusting the camera settings

In the **Properties** panel, click the **Render** tab. There are several important settings here.

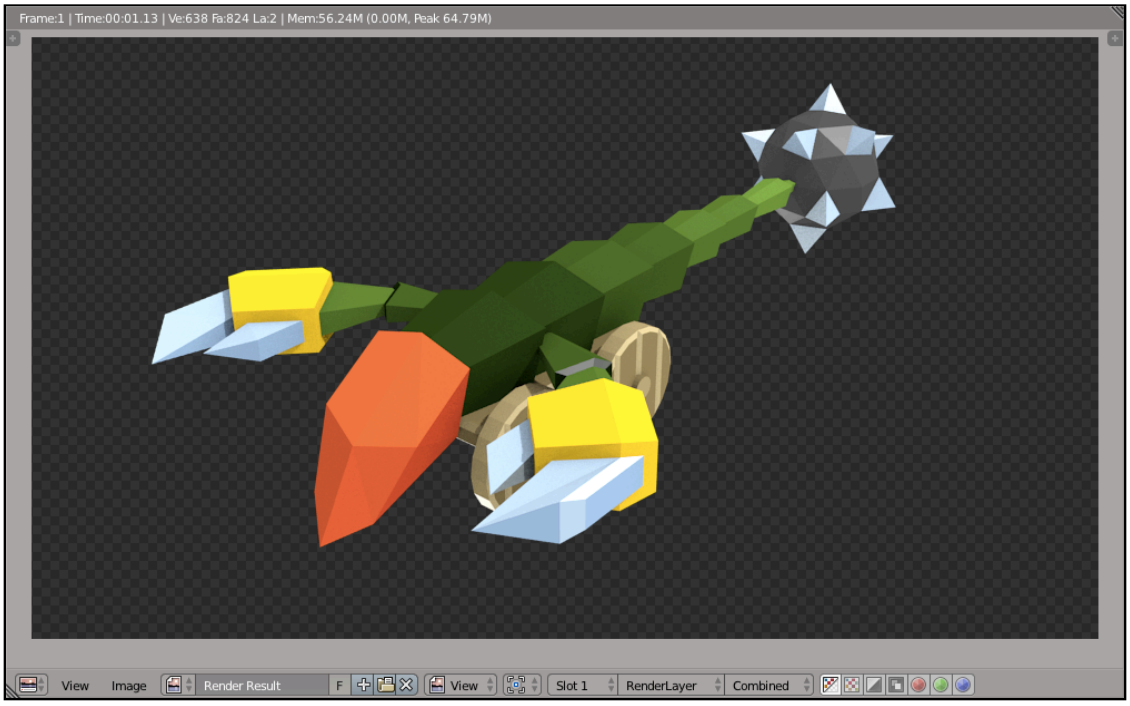
1. **Resolution** set the width (X) and height (Y) of your render. Note that the % slider in that section is applied to those dimensions. If your render is set to 1920 x 1080, and the slider is set to 50%, your final render will be 960 x 540.
2. To create a transparent PNG, scroll down to the **Shading** section and change the **Alpha** popup to **Transparent**.
3. Scroll down to the **Output** section and change the File Format to **PNG\RGBA**.



Rendering and saving an image

1. Press **F12** to render the scene using the camera. This replaces the entire 3D View with a UV/Image Editor panel, displaying your shiny new render.

2. In the menu bar at the bottom of the window, select **Image\Save as Image** (or press **F3**). Choose a place on your computer to save it, and you're done!



Press **Esc** to return to the 3D View.

Where to go from here?

Congratulations! You have taken plain grey geometry and given it a vibrant splash of color. As you experiment with Blender more and more, try adding different graphics or "decals" to parts of your texture, then mapping those to different faces of your model to further customize its look.

So far you've learned:

- **How to create a 2D texture** in GIMP.
- **How to set up basic lighting** for your scene.
- **The basics of texturing models** using UV Maps and 2D textures.
- **How to configure the camera** and render beautiful images of your creation.

In the following chapter, you will learn how to rig and animate your model.

Summary of keyboard commands

L - Select Linked

Alt-click - (on an edge in Edit Mode) Loop Select

U - UV Unwrap selected faces

Ctrl + - Select More

Ctrl - - Select Less

Ctrl-J - Join Objects

Shift-Z - Toggle rendered view

N - Toggle Properties panel

T - Toggle Tools panel

0 (zero) - Switch to camera view

F12 - Render

F3 - Save image

Chapter 17: Animating in Blender

By Mike Berg

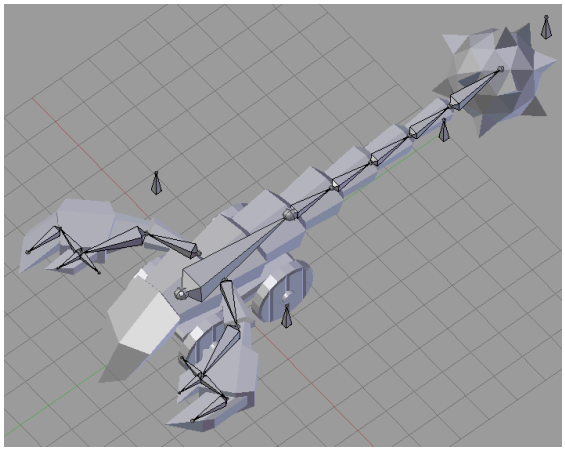
The journey of bringing your model to life is almost over. The only thing left? Animation! Nothing makes a character feel more alive than animation.

> **Note**: This chapter builds on the skills learned and the model made in Chapters 15 and 16. I recommend you read through those chapters before this one.

Getting started

Like many animation tools, Blender uses something called a **Rig** to create animation. Rigs are made up of (among other things) an **Armature**, which consists of one or more **Bones**. A mesh is then applied to a rig, and when the bones move, the mesh moves with it. Think of bones in Blender just like bones in your body; they give you joints and define where and how you can move.

Here's what the armature for your scorpion will look like:

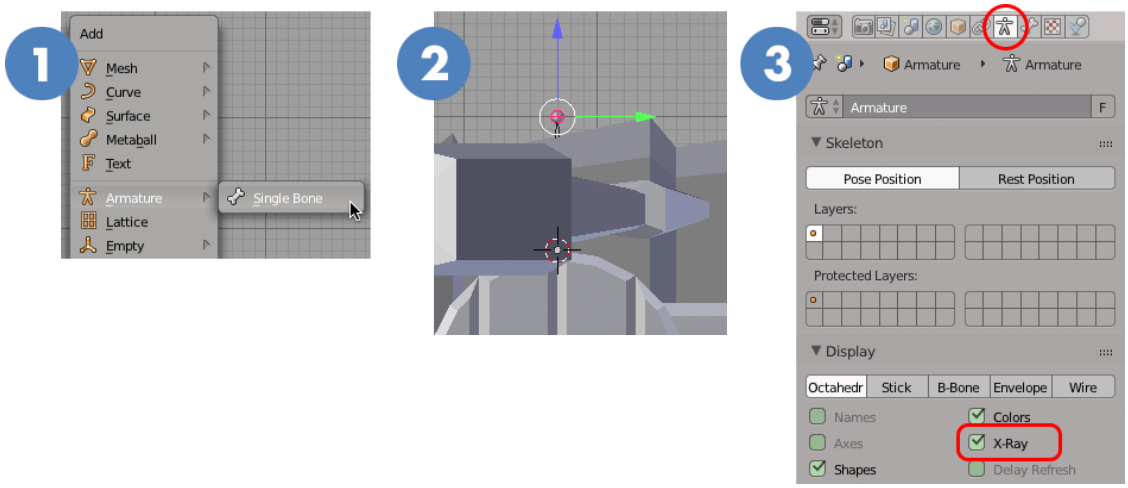


Creating the rig

Start by selecting the Body object, pressing **Shift-S**, and selecting **Cursor to Selected**. The 3D Cursor snaps to the origin of the Body object. This is a good starting point for your armature.

Adding the first bone

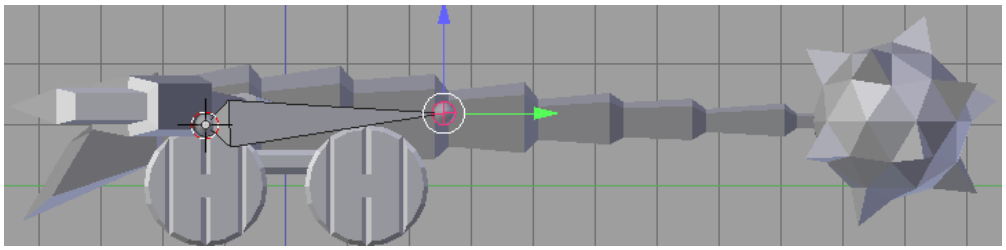
1. Press **Shift-A** and select **Armature\Single Bone** to create your first bone.
2. Press **3** to switch to Side View, and press **Tab** to enter **Edit Mode**.
3. It's a bit tough to see because most of the bone is inside the body geometry. In the **Properties** panel, click the **Armature** tab and select the **X-Ray** checkbox, so that you can see your bones even when they are inside an object.



Edit Mode for bones is slightly different from editing meshes. A bone can be selected by clicking on the middle part of the bone. Each bone also has two **ends**, that appear as spheres at the end of each bone. These ends can be selected and moved independently by clicking on one and pressing **G** to Grab (move) it.

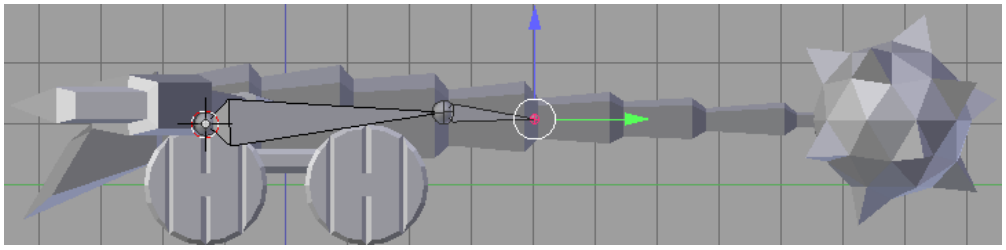
> **Note:** When you have an armature selected, the "Object Mode / Edit Mode" popup has a new item in it: **Pose Mode**. Be careful not to accidentally enter Pose Mode when you need to be in Edit Mode. In Pose Mode, the bones display with a light blue outline.

Select the top end of the bone and press **G** to move it to the right. Line it up with the end of the segment — and closer to the top than the bottom — as shown here:

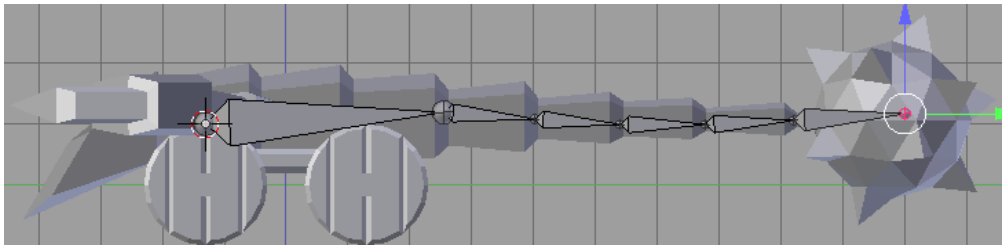


Using 'Extrude' to create more bones

Press **E** and drag your mouse to the right to **Extrude** the bone's end, creating a whole new bone. Click when you are happy with the new bone's position.



Repeat the extrude step to create a bone for each segment of the tail. The curve of the tail should be slightly concave; this will help us out later, when you curl the tail upward.



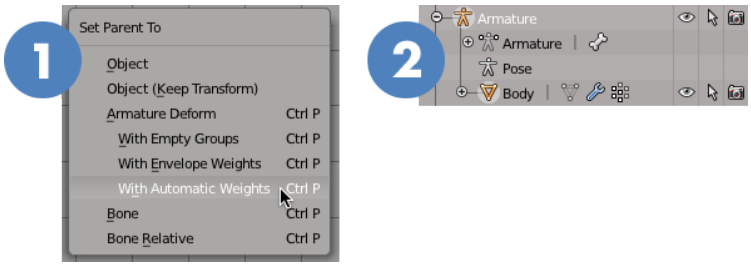
Attaching the mesh to the armature

Press **Tab** to return to Object Mode. Press **A** to Select None. Click the Body object to select it, then hold **Shift** and click the armature, so they are both selected. This can be hard to do in the 3D View, because the armature is inside the body. If so, use the **Outliner**, at the top-right, to make the selection.

> **Note:** Selection order matters. Make sure you select the armature **last**.

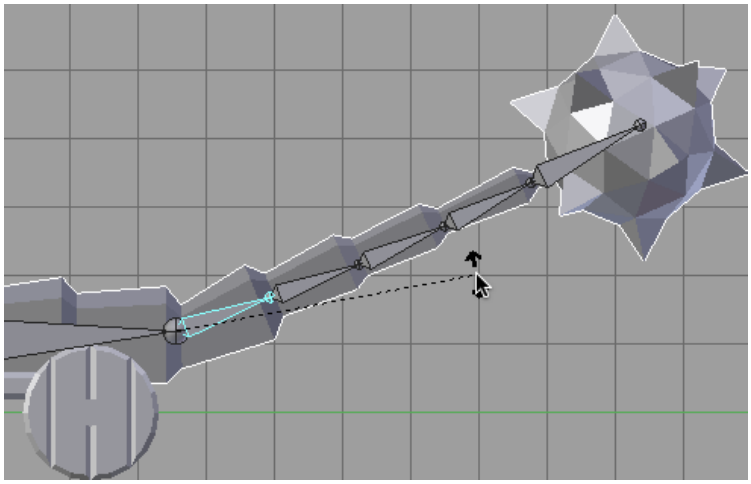
1. Press **Ctrl-P** and select **Set Parent To Armature Deform\With Automatic Weights**.

2. Nothing will appear to change, but if you look in the **Outliner**, you'll see that the Body is now a child of the Armature.



Pose Mode

Here's where the real fun begins. Click the **Object Mode** popup at the bottom of the screen and select **Pose Mode**. Click the second bone in the armature and press **R** to rotate it. The tail moves with it!



Now, that's definitely cool, but animating this tail by rotating each individual joint would be a pain. Thankfully, there's an easier way...

Inverse Kinematics

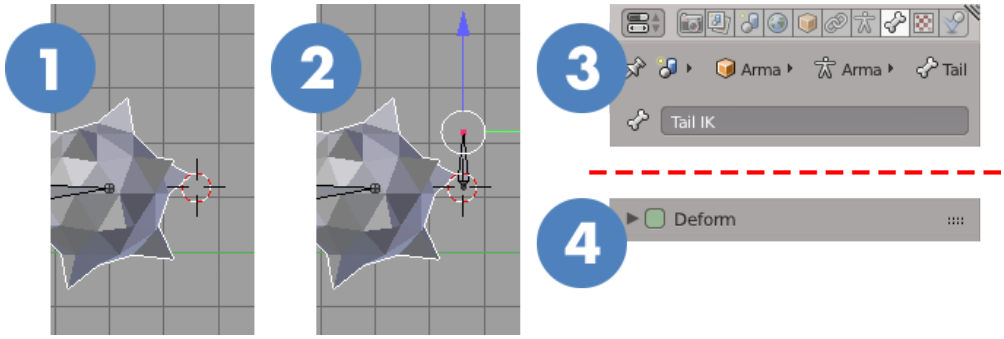
The animation style just described (rotating each tail bone one at a time, until you get to the end of the tail) is known as **Forward Kinematics**. **Inverse Kinematics** uses a target bone that the entire chain aims at. Moving the **IK Target** automatically adjusts the rotation of each of the bones in the chain. This way, you only have to animate one object.

1. Switch back to **Edit Mode**, and right-click to the right of the spiked ball to move the 3D Cursor there.

2. Press **Shift-A** to add a new bone. Press **A**, then click the body of the bone, to select the entire thing.

3. In the **Properties** panel, click the **Bone** tab and change the name of the bone to **Tail IK**. It's a good idea to name all your bones, especially the ones you plan to animate; you will identify them later by their names in the animation window.

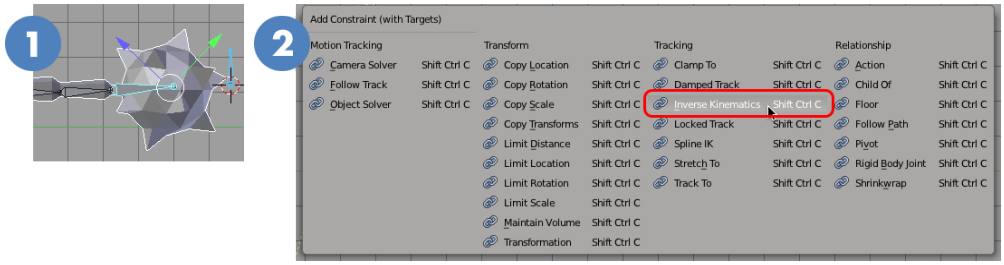
4. Near the bottom of the **Bone Properties** panel, deselect the **Deform** checkbox. You do not want this bone to deform the mesh.



Creating the IK Target

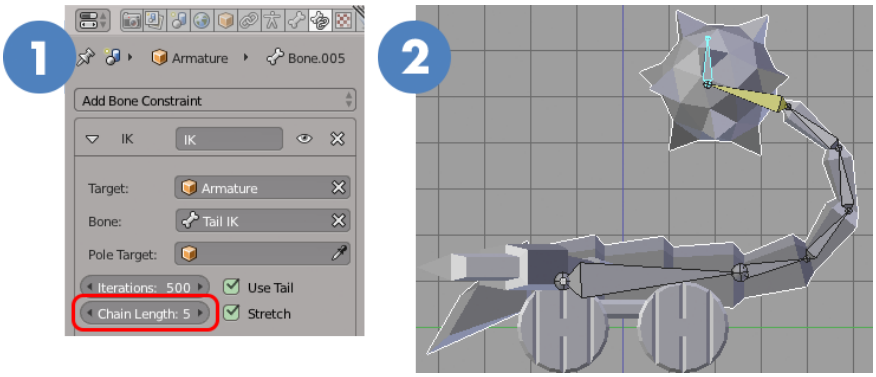
1. Switch to **Pose Mode**. Select the IK bone first, then Shift-select the last bone in the tail.

2. Press **Shift-Ctrl-C** to open the **Add Constraint (with Targets)** menu. Under **Tracking**, select **Inverse Kinematics**.



1. Select the last bone in the tail (it is now highlighted yellow). In the **Properties** panel, click the **Bone Constraints** tab and look for the **Chain Length**. The tail has 5 bones, so change the **Chain Length** to 5. This limits the number of bones that are affected by the IK target.

2. Select the **Tail IK** bone and press **G** to move it up over the body of the model. Now *that* is magic!



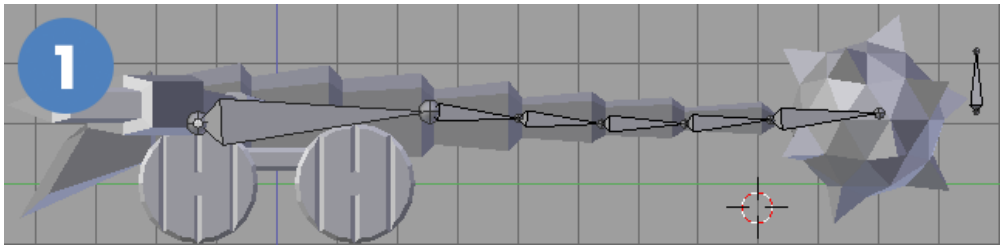
Creating a Pole Target for the tail

This rig is working very well, but it can be even better. If you were to animate it now, the spiked ball would *always* lead the way, and the tail would follow. It would look a bit like the head of a snake moving around. That might look cool, but it would also have the effect of making that big spiked ball look very light weight.

Think of a pitcher throwing a baseball. They draw their elbow back first, then their forearm and the ball *follow* the elbow.

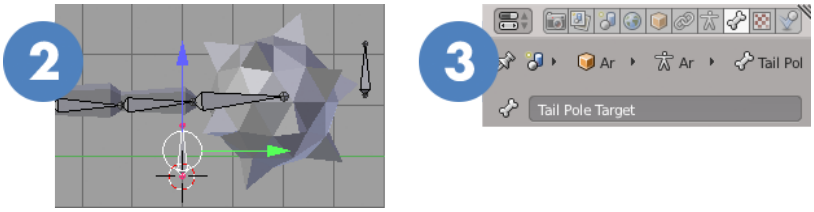
To make your spiked ball look heavy and feel real, you need to be able to move the tail a bit, separately, so that it can lead and the ball can follow. To do this, use something called a **Pole Target**.

1. Switch to **Edit Mode**. Notice how the pose you made in Pose Mode is not shown; the model snaps back to its "Rest Position". Don't worry, your pose is still saved. **Right-click** below the tail to move the 3D Cursor, as shown.



2. Press **Shift-A** to add a bone. Press **A** to Select None, then click on the middle of the bone to select it.

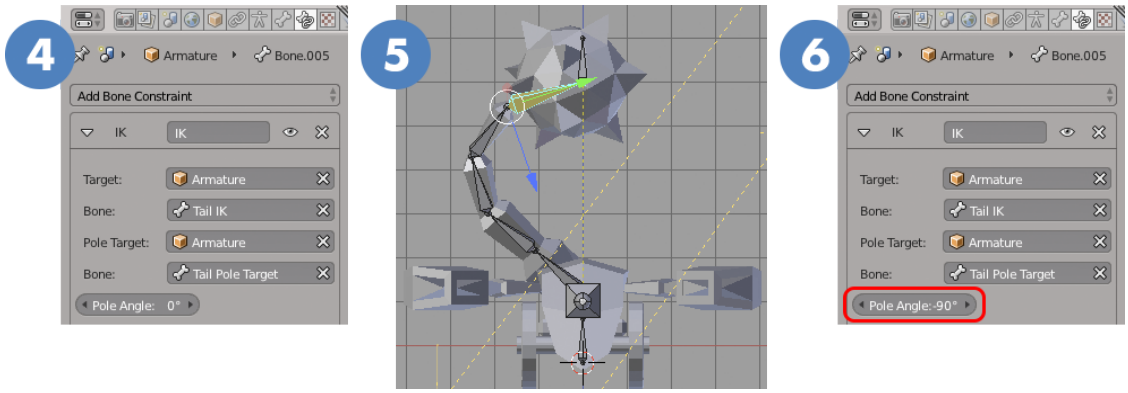
3. In the **Properties** panel, switch to the **Bone** tab and rename the bone to **Tail Pole Target**. Don't forget to deselect the **Deform** checkbox.



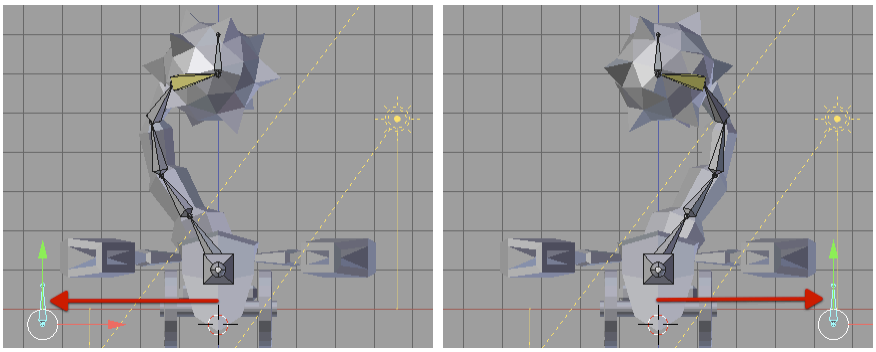
4. Switch back to **Pose Mode** and select the yellow bone at the end of the tail. In the **Properties** panel, click the **Bone Constraints** tab, click the **Pole Target** field, and select **Armature**. Another field appears below that lets you choose the specific bone. Select the **Tail Pole Target** bone.

5. Press **1** to switch to Front View. It doesn't look quite right... the tail is pointed to the side, instead of at the Pole Target!

6. Back in the **Bone Constraints** tab, find the **Pole Angle** field. Click and drag side-to-side to adjust this number and see how the changes affect your model in real time. In this case, a value of **-90 degrees** works perfectly.



Press **3** to go back to Side View, then select the **Tail Pole Target** bone and press **1** again to switch back to Front View. Move the bone left and right (**G** to grab) to see how it affects the tail.



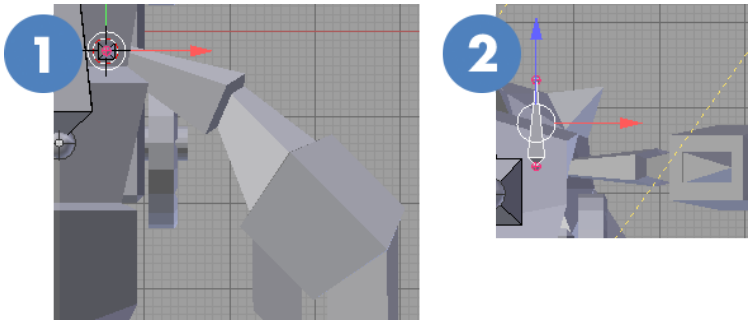
Fantastic! The rig for the tail is now complete.

Adding the arm bones

Select the existing armature and enter Edit Mode. You'll use the same armature for the arm bones.

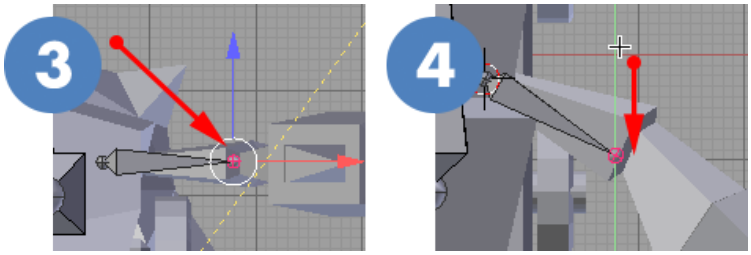
1. Start in Top View, set your 3D Cursor to the spot where the left arm meets the body. Press **Shift-A** to create the first bone.

2. Press **1** to switch to front view, as your first bone is created in an upright position. Click the middle portion of the bone to select the whole bone. Drag the blue arrow up until its base is in line with the center of the arm.



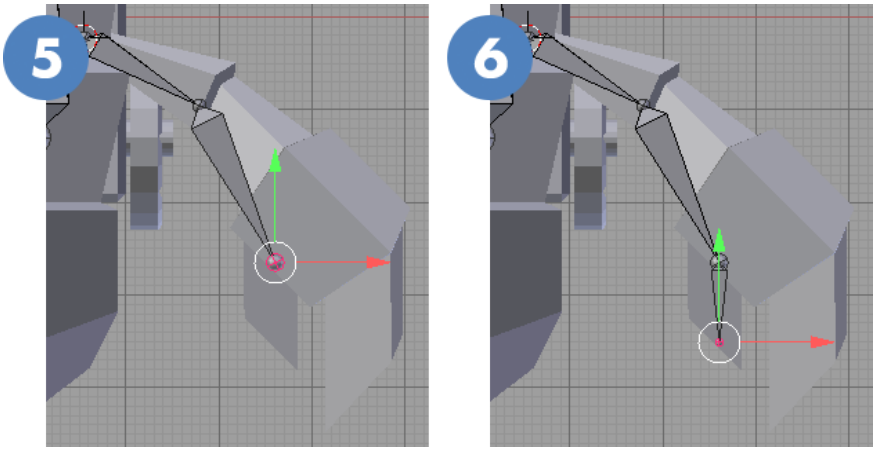
3. Press **A** to deselect, then select the end of the bone, and press **G** to grab it and move it approximately to the elbow.

4. Press **7** to switch to top view. Drag the green arrow to move the end of the bone forward to align it in this view too.



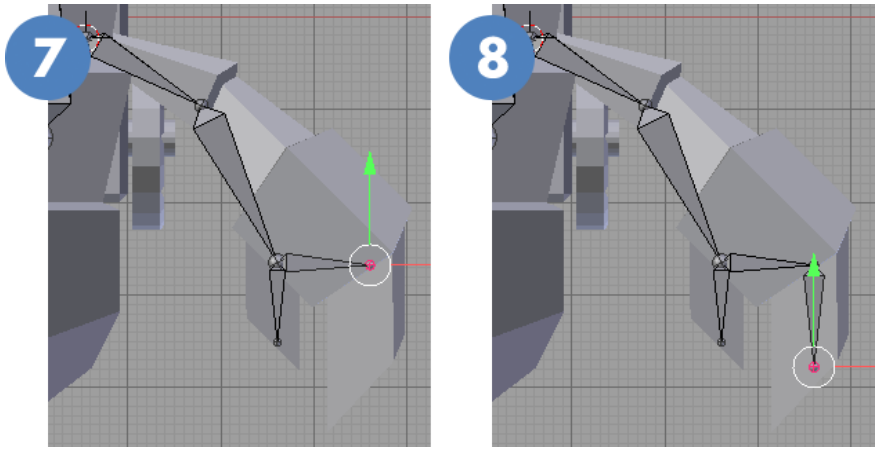
5. Stay in top view and press **E** to extrude a new bone to the midpoint of where the "thumb" meets the "hand", shown here.

6. Press **E** again to extrude a "thumb" bone.



7. Click the end of the **2nd bone** and press **E** to extrude a bone to the midpoint of where the large claw meets the "hand".

8. Press **E** to extrude the bone for the large claw.

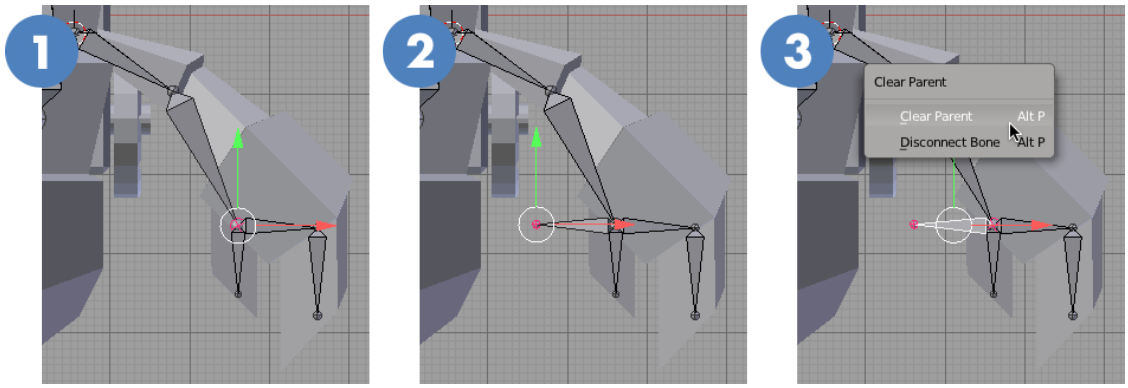


Note: Name each bone, and be sure to use ".L" at the end of each name. In the **Properties\Armature** tab, select the **Names** checkbox to see bone names right in the 3D View.

Adding the arm IK Target

Another way to create an IK Target is to extrude it right from the joint you want to have pointing at it. You want the "hand" to point at the IK Target to control the arm, but not the claws, which will be animated separately.

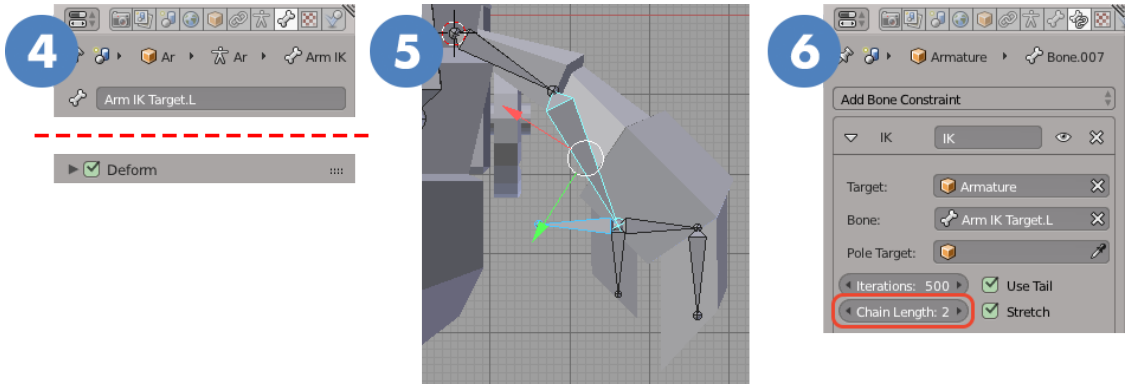
1. Select the sphere at the intersection of the arm and "thumb" bones.
2. Press **E** and extrude a bone out to the left.
3. Press **A** to Select None, and click the bone itself. Press **Alt-P** and select **Clear Parent**. This takes the bone out of the hierarchy, but it's still part of the same armature.



4. In the **Properties** panel, under the **Bone** tab, rename the bone **Arm IK Target.L**. Don't forget to scroll down and deselect the **Deform** checkbox.

5. Switch to **Pose Mode**, select the **Arm IK Target.L** bone first, then Shift-select the "forearm" bone. Press **Shift-Ctrl-C** and select **Inverse Kinematics**. The forearm turns yellow.

6. Select the forearm. For the purposes of IK, this arm has two bones. In the **Properties\Bone Constraints** tab, set the **Chain Length** to **2**.

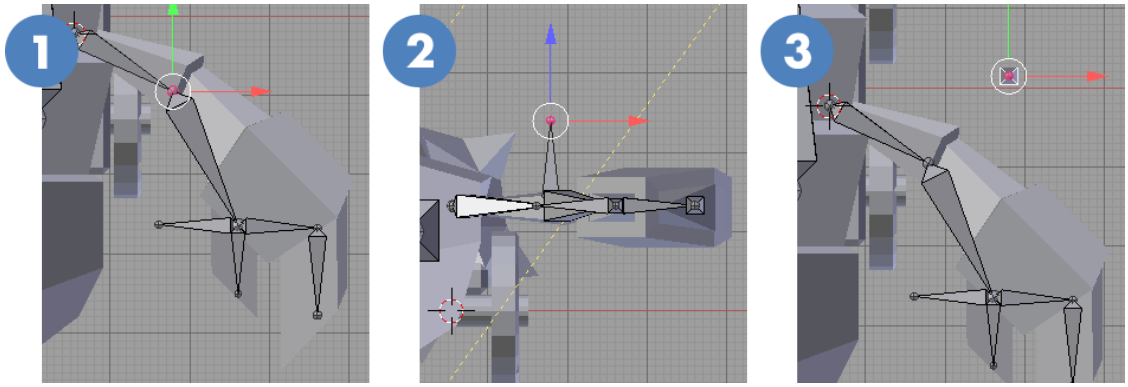


Adding the Pole Target for the elbow

1. Switch to **Edit Mode**. Select the sphere at the "elbow" of the arm.

2. Press **1** to switch to Front View, and press **E** to extrude the arm upward.

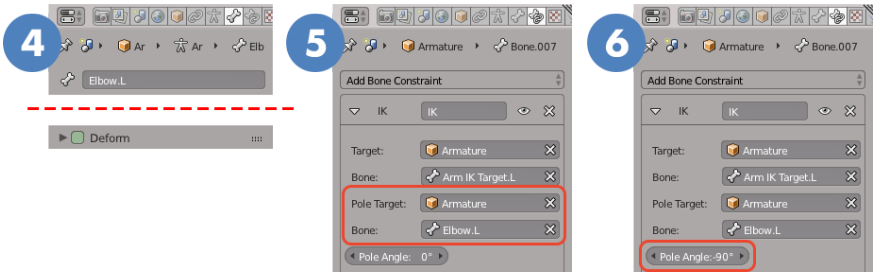
3. Press **A** to Select None, then select the bone, press **Alt-P** and select **Clear Parent**. Press **7** to switch to Top View, press **G** and drag the bone away from the arm a bit.



4. Don't forget to go to **Properties\Bone** to name the bone **Elbow.L**, and deselect the **Deform** checkbox.

5. Switch to **Pose Mode** and select the forearm bone. Go to **Properties\Bone Constraints**, click the **Pole Target** field, and select **Armature**. Below that, select the **Elbow.L** bone.

6. Orbit around your model to ensure the elbow is pointed at the Pole Target. If it's not, adjust the **Pole Angle** until it looks right. **-90** worked for me.



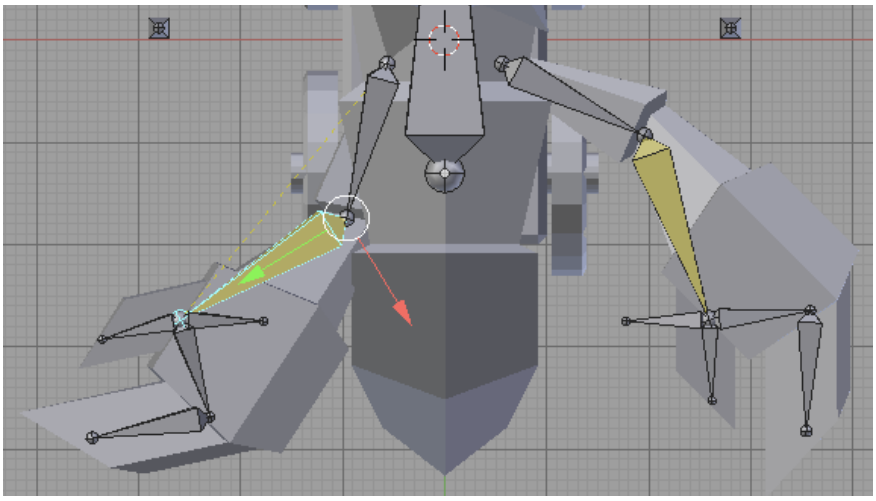
Note: In Blender, input fields that have arrows on the left and right side can be adjusted by clicking on them and dragging left and right.

Flipping the arm bones for the other arm

1. Remember when you flipped the arm geometry in the modeling chapter? Flipping the bones is the same: First, make sure you're in **Edit Mode**, then press **Shift-S** to snap the 3D Cursor to the center. Press **. (period)** to transform around the cursor. Select all the arm bones, including the IK and Pole Targets, and press **Shift-D** then **Enter** to duplicate. **Ctrl-M X** then **Enter** to mirror over the X axis.

2. In the menu at the bottom of the 3D View, select **Armature\Flip Names** to automatically rename bones with **.L** to **.R**, for the right arm.

3. Switch to **Object Mode**. You've created new bones, but they have not had their Automatic Weights set up for the mesh. Select the mesh, then **Shift-click** the armature. Press **Ctrl-P** and select **Set Parent To Armature Deform\With Automatic Weights** again. The mesh is already parented to the armature, so now it just recalculates the automatic weights; this time for all the new bones, too.



4. What happened to the right arm? When the bones got flipped, the **Pole Angle** for the elbow stayed the same. Switch to **Pose Mode** and select the yellow-

highlighted bone in the right arm. In the **Properties** panel, click the **Bone Constraints** tab, and change the **Pole Angle** to **90**.

Your rig is now complete! Time for some movement...

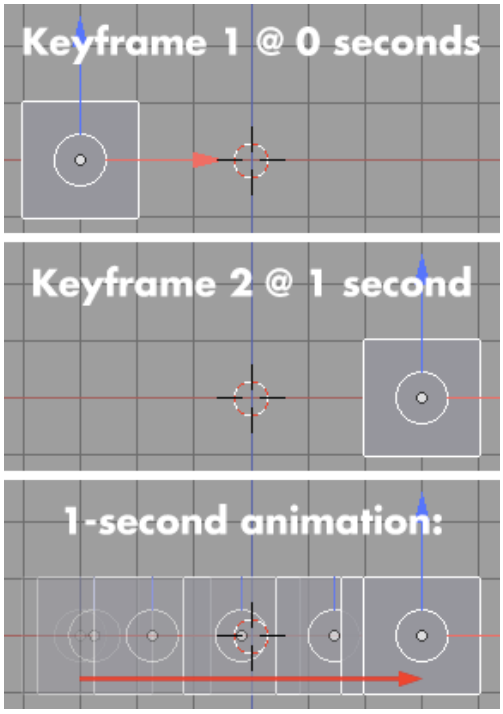
> **Note:** Don't forget to save. If you want to look at the rig I made, open **02-Scorpion-Rigged.blend** in the Resources folder.

Animation

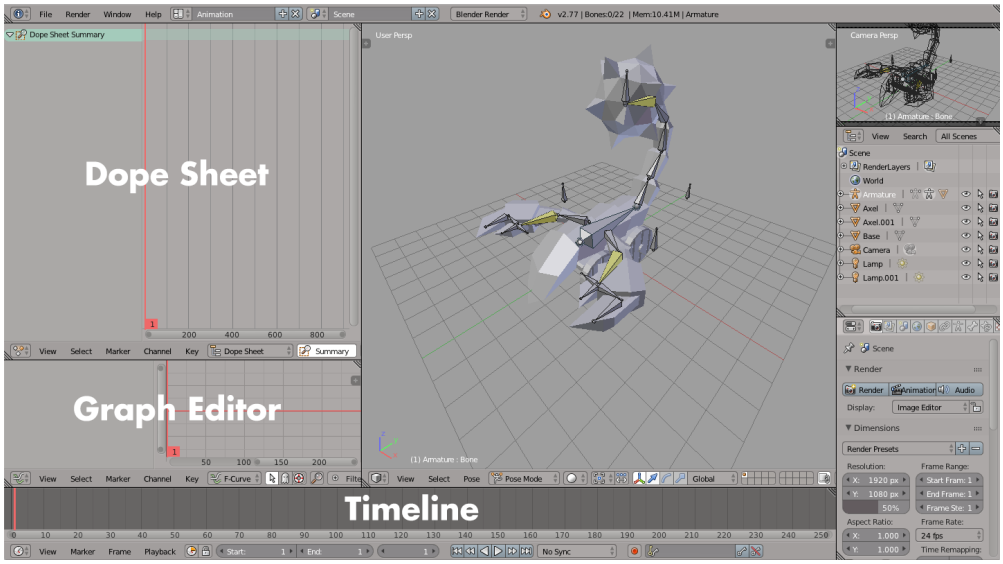
Creating animation in Blender is similar to most other animation applications; it uses **keyframes** and **tweening**.

A keyframe is a point in the **timeline** where you have specified the position, for example, of an object. Then you set another keyframe at a different point in time, with the object in a different position.

When you play the animation, the object will move smoothly from the position set by the first keyframe, to the position set by the second keyframe. This automatically-generated motion between keyframes is called **tweening**.



At the top of the screen, switch to the **Animation** workspace. There are some new panels here:



- The **Dope Sheet** shows you an overview of everything that is animated, in your scene. Every property that you animate will show up as a channel in the left column, with its keyframes displayed in the timeline column on the right.
- The **Graph Editor** displays a motion graph for selected keyframes. This lets you fine-tune the speed of each tween; slowing down or speeding up an animation on either side of a keyframe. This is called **easing**.
- The **Timeline** shows a simplified overview of your entire timeline, along with playback controls.

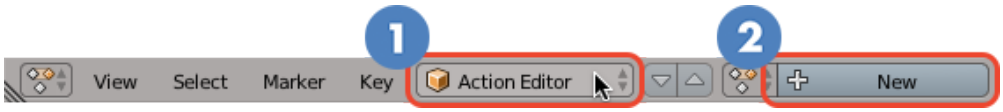
> **Note:** To move the playhead in any timeline view, **Right-click & drag**. Zoom and Pan controls are almost the same as in the 3D View: **Scrollwheel** to zoom, and **Middle-click & drag** to pan. Holding Shift to pan is not necessary in a 2D panel.

Creating an Action for the tail animation

Blender allows you to create multiple animations for a single armature, which can be triggered independently in Unity. Each animation is called an **Action**. You'll use Actions to create a looping animation for a swaying tail, and a separate, non-looping animation for a swinging claw.

> **Note:** For more information on how to trigger these animations in Unity, see Chapter 5, "Animations".

1. At the bottom of the Dope Sheet panel, click the **Dope Sheet** popup and select **Action Editor**.
2. Click the **New** button to create a new Action.

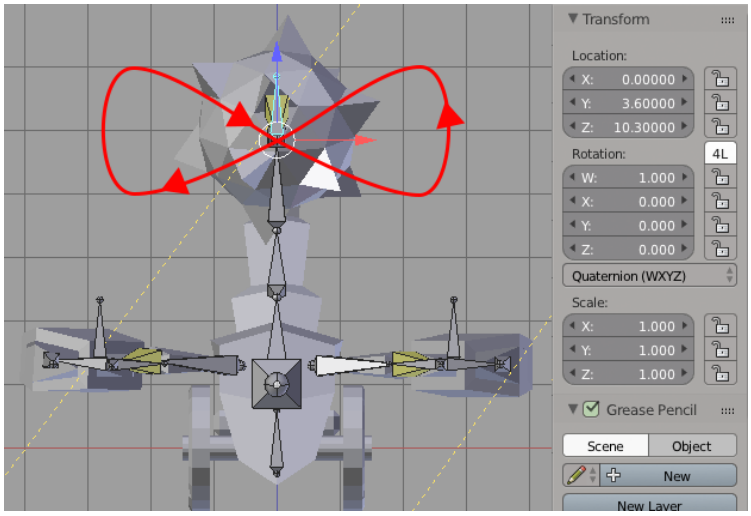


3. Click the **Action** name field and change the name to **Tail Sway**.
4. **Important**: Click the **F** button next to the name. This gives the Action something called a Fake User, and forces Blender to save your action, even if it is unlinked. I won't go into detail on this, except to note that your Action may not be saved if you do not press this button!

Creating keyframes

First up, you'll create a looping animation for the tail, so that it bobs back and forth as the minion trundles along its path. In the 3D View, press **1** to switch to Front View, then **5** to turn off perspective. Press **N** to turn on the **Properties** shelf.

You'll animate the **Tail IK** bone to move along a path like this:

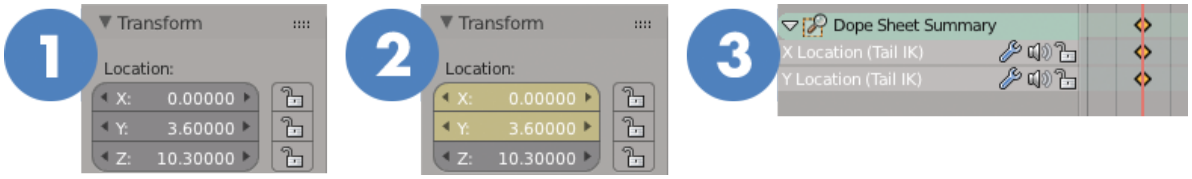


Note: I'll be giving you exact coordinates for each keyframe, but feel free to eyeball it and use what looks right to you. The values you use may also be slightly different, since they are relative to where the **Tail IK** bone was first created.

1. Make sure you are in **Pose Mode**, and select the **Tail IK** bone. In the Properties shelf, set the **Location** coordinates to: **X 0, Y 3.6, Z 10.3** (as shown at the top-right of the screenshot above).

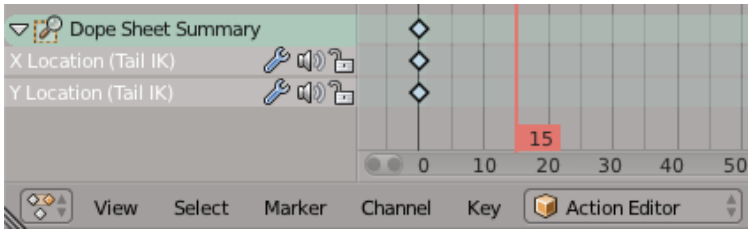
2. Make sure the playhead is on frame zero, then **right-click** on the X field (the one you just set to zero) and select **Insert Single Keyframe**. Do the same for the Y field. *The fields turn yellow to show that they have been keyed.*

3. Look in the Dope Sheet; a new channel appears for each of the values you have keyed, with the name of the value — **X Location** — followed by the name of the object in brackets — **(Tail IK)**. The keyframe itself displays as a diamond on the Dope Sheet's timeline.

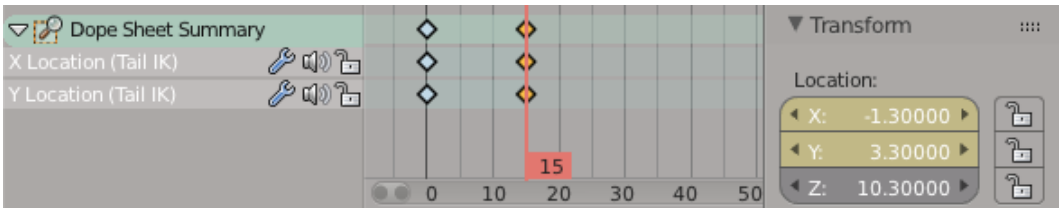


Great, you've created your first keyframes! There's nothing moving yet, since this is just a starting position. Create some more keyframes to see some action:

4. **Right-click** and drag on the timeline to move the playhead to frame 15. Remember that you can use the scroll wheel to zoom in; middle-click to pan/scroll around.



5. Make sure the **Tail IK** bone is still selected, and change the location values to: **X -1.3, Y 3.3** (you won't be animating the Z value at all, so leave that one alone). Right-click on each field after you change it and select **Insert Single Keyframe**.



6. At the bottom of the Blender window, in the Timeline panel, set the **End** field to **80**. This gives your animation a duration of 80 frames. Press the **Play** button to preview your animation.

> **Tip:** Press **Alt-A** to play/pause the playhead at any time. You can orbit the 3D View while the animation is playing, to get a good view of it from any angle.

Here are the frame numbers and the coordinates for the rest of the keyframes. Don't forget to right-click and select **Insert Single Keyframe** after you make each change, *before* you move the playhead, or your changes won't be keyed.

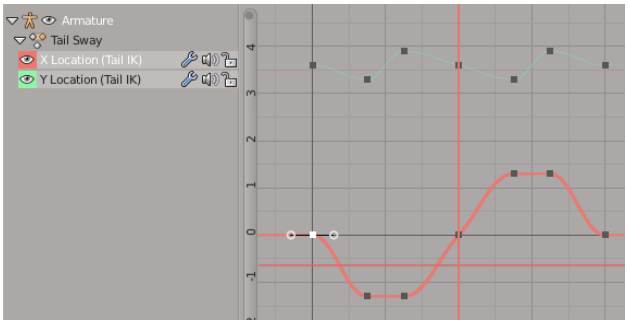
- **Frame 25** - X -1.3, Y 3.9
- **Frame 40** - X 0, Y 3.6
- **Frame 55** - X 1.3 Y 3.3
- **Frame 65** - X 1.3 Y 3.9
- **Frame 80** - X 0 Y 3.6

Your Dope Sheet should look like this:

Press **Alt-A** to preview your animation. It's getting there, but the motion feels a bit wooden; it doesn't flow as naturally as it could. To fix that, shift your attention to the **Graph Editor**.

The Graph Editor

At this point, your Graph Editor panel should look like this:

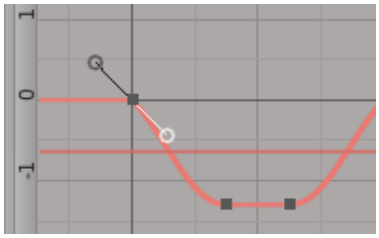


Feel free to zoom in to see more detail, if your graph looks small. Note also that you can drag the panel edges to resize any panel.

The Graph Editor charts a curved line for each animated channel. The **horizontal** axis represents **time**; the **vertical** axis represents the **value of the channel**. The **points** on the line represent **keyframes** that you've set.

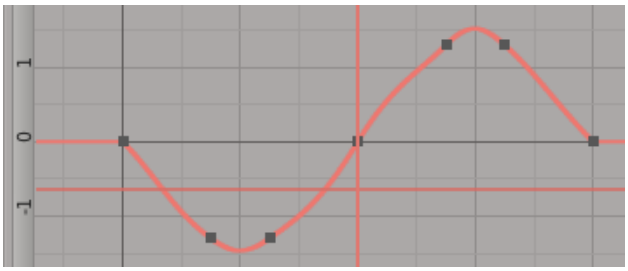
Using the Graph Editor to create smooth motion

Click the first point on the **X Location** curve. Once selected, each point has handles on either side that control the strength and direction of the curve. Drag the handle on the right so that it is approximately 45 degrees:



This will create a smoother looping motion, when the animation goes from frame 80 back to frame 1.

Smooth out the curves on all the points, so that your path looks more like this:



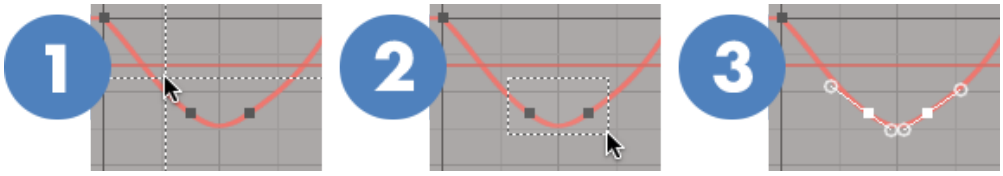
> **Note:** When editing the points on a curve, you need to click and drag a bit to get the handle moving, then **release** the mouse button. The handle will still be active, and moving the mouse will reposition it. **Click** again, to finish the adjustment.

Press **Alt-A** to preview the animation. Much better already! But it can be a bit better, still.

Look at the Graph Editor; see how the valley and peak of your loop don't look quite right? They're not quite as smooth as they could be. The two keyframes on either side are a bit too close together.

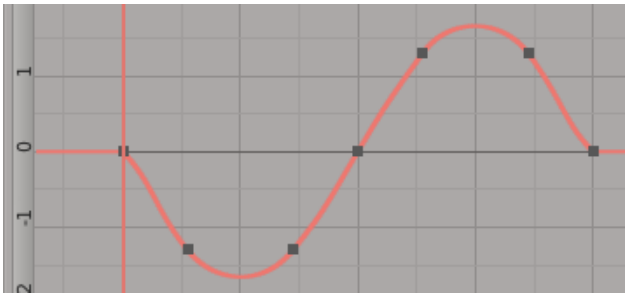
To fix this, you'll use a familiar tool (Scale), and one new one: **Box Select**. You *could* Shift-select the two points you want to adjust, but there's an easier way.

1. Press **A** to Select None, then press **B** to invoke the **Box Select** tool.
2. Click and drag around the objects you want to select.
3. The objects are selected.



> **Note: Box Select** can be used in almost any panel in Blender.

Now that you have your keyframes selected simply press **S**, then drag your mouse to scale them. Pull the keyframes away from each other nicely, until you have a nice rounded curve. Repeat this for the keyframes at frames 55 and 65, so that your graph looks like the screenshot below. You may need to tweak the handles on your points a bit, after scaling them.



Have a look at the Dope Sheet. Note how the keyframes for the **X Location** channel have moved; this is simply reflecting the changes you made in the Graph Editor.

> **Note:** Select a point and type **G Y** to move it vertically in the Graph Editor. If the playhead is on the same frame as the keyframe, you will see your change reflected in the 3D View. This is a quick way to visually edit keyframes in a motion curve.

Don't forget to save!

Animating the Pole Target

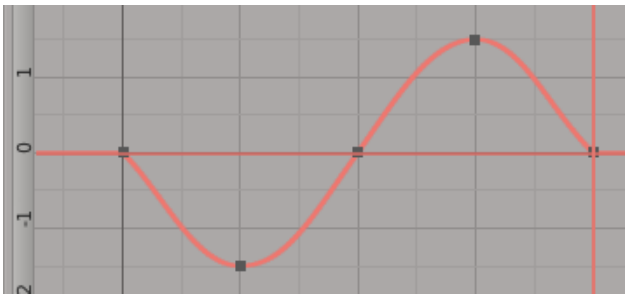
The tail animation is looking good, but remember when I talked about that big heavy spiked ball looking light-weight? It's time to animate the Pole Target to make the tail lead the ball a bit, to make it look like it's pulling it along.

Make sure you are still in Pose Mode. Select the **Tail Pole Target** bone. This object will only slide from side to side, so you'll only need to animate the **X Location** value.

Here are the keyframes to set:

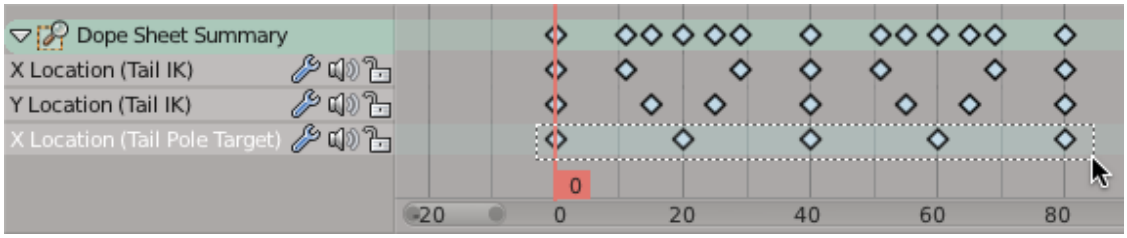
- **Frame 0** - X 0
- **Frame 20** - X -1.5
- **Frame 40** - X 0
- **Frame 60** - X 1.5
- **Frame 80** - X 0

In the Graph Editor, tweak the points so that they are nice and smooth, giving you a curve like this:



Preview the animation now, and it will look almost exactly the same as it did before! That's because the Pole Target is moving in sync with the tail. To get it to *lead* the tail a bit, you need to adjust the timing.

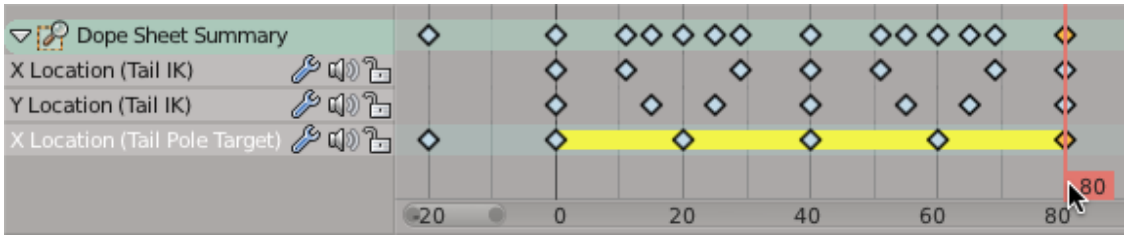
In the Dope Sheet, press **B** and Box Select all the keyframes in the **X Location (Tail Pole Target)** channel.



Press **G -20**, then **Enter** to move the selected keyframes 20 frames to the left.

Preview the animation now, and you'll see that the tail is leading the way. Nice! But the animation no longer loops correctly. In the Dope Sheet, press **A** to Select None, and click on the keyframe at frame 0 to select it.

Press **Shift-D** to duplicate. Drag the duplicate keyframe all the way across the timeline and **left-click** when it's on frame 80.



Now press **Alt-A** to preview your animation. Orbit around your scene a bit, while it's playing, to get a good look at how your Pole Target is affecting the tail.

That's it for the tail animation. Great work! Time to create a new Action for the arms.

Don't forget to save.

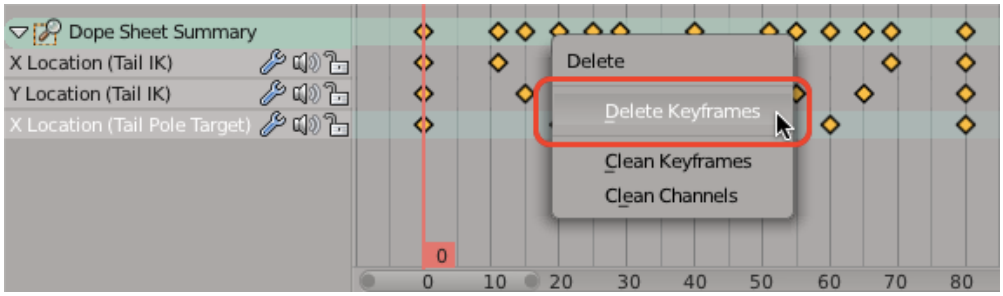
Creating an Action for the claw animation

The tail sway is complete; now you need a new **Action** to store the next animation.

1. At the bottom of the Dope Sheet, click the **+** button next to the **Tail Sway** action name to create a new Action.

2. Blender actually duplicates the current action; rename the new Action **Claw Attack.L**. Don't forget to click the **F** button.

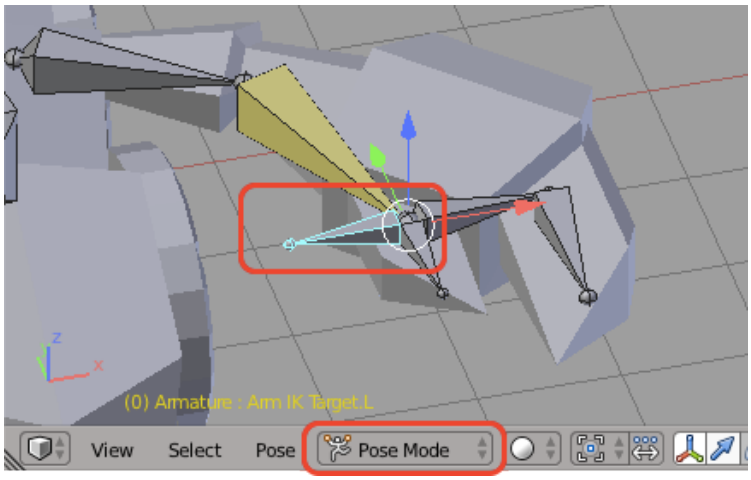
3. Now the keyframes need to be deleted. Move your cursor over the Dope Sheet and press **A** to Select All, then **X**, followed by **Delete Keyframes** to delete them.



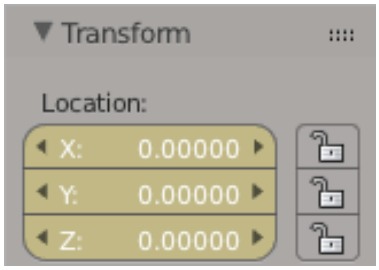
Animating the claw

Start by animating the IK Target for the left arm; **Arm IK Target.L**.

1. Make sure you are still in Pose Mode, and select that bone.



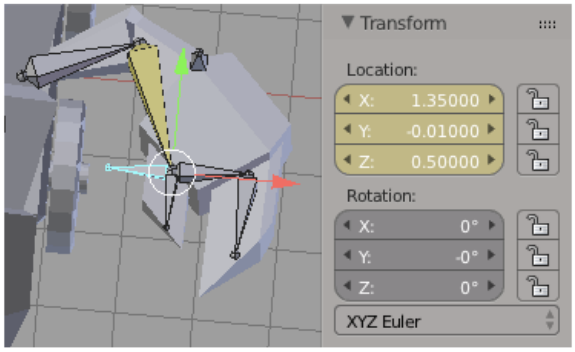
2. Right-click on any of the axes in the **Location** section of the Properties shelf. This time, you'll create a keyframe for all three axes at once by selecting **Insert Keyframes**. All three fields turn yellow; your starting keyframes for this bone are now set.



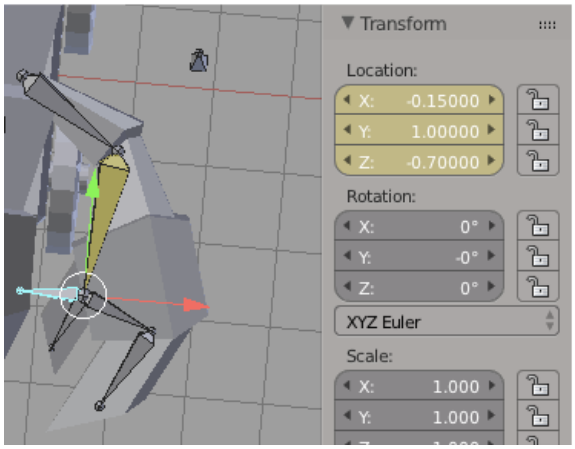
> **Note:** Only keyframe all three axes if you know the object will be moving in all three directions. Creating keyframes only for the axes you are animating keeps your Dope Sheet nice and clean. This becomes more important as your animations get more complex.

3. Continue creating the following keyframes for the **Arm IK Target.L** bone:

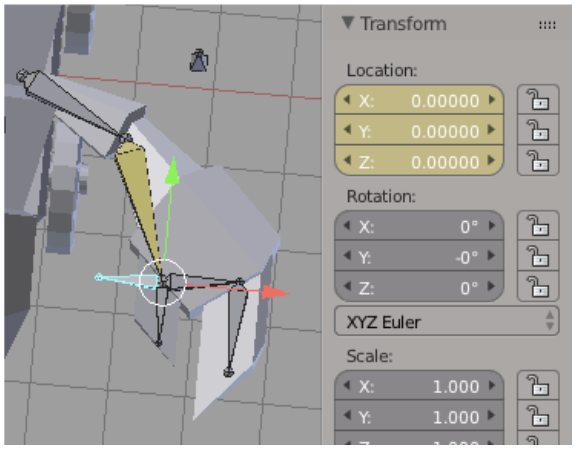
Frame 20:



Frame 40:



Frame 65:

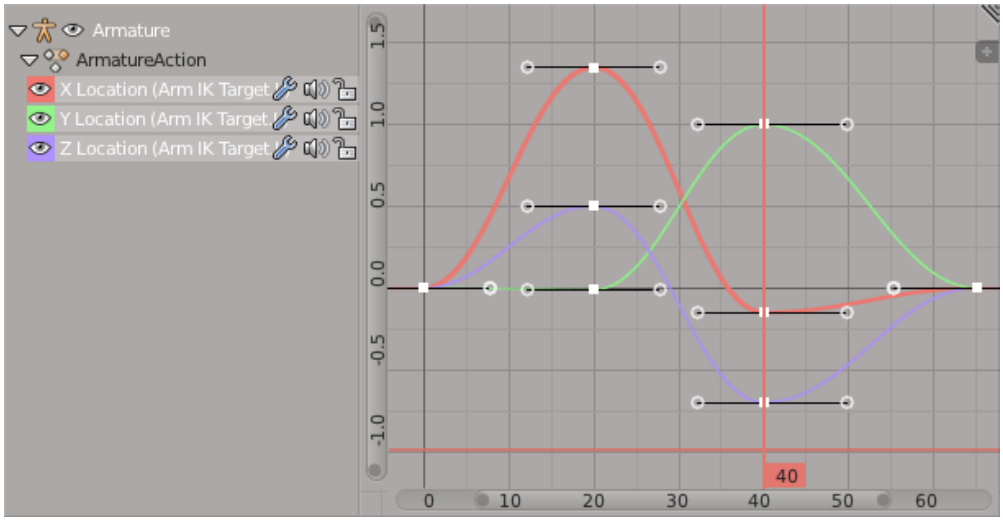


Now you have the basic movement keyed for a claw attack. Press **Alt-A** to preview your animation. It's coming along, but it's definitely not quite right yet. This time, the tweened animation is *too smooth*. Remember, adjusting the tweening involves the Graph Editor.

Creating sharp, sudden movement with the Graph Editor

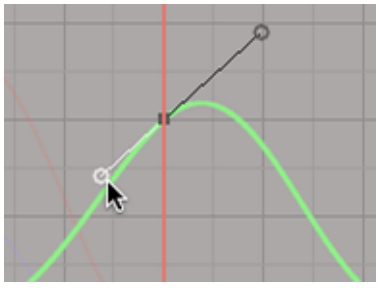
Right now, the claw attack looks more like a friendly wave. You want the claw to quickly dart forward, hit whatever it's attacking, and bounce off.

At this point, the Graph Editor should look like this:

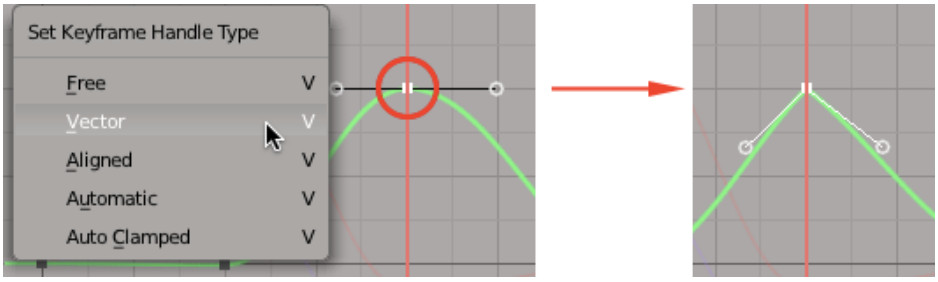


Note: See the small dots at the ends of each scroll bar? Try dragging them to adjust the vertical or horizontal scale of the graph.

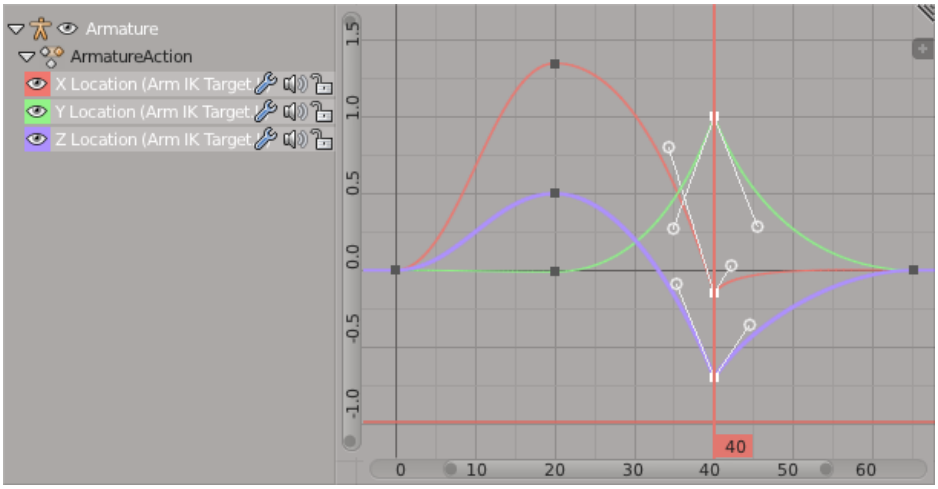
The tip of the attack animation is at frame 40. Making a sudden change in direction involves changing the curves at this frame to a sharp angle. However, simply dragging a handle doesn't create a sharp angle, it only adjusts the curve:



To create a sharp angle, you need to change the **Keyframe Handle Type**. Select the keyframe itself — the dot in the middle, not one of the handles on either side — press **V** to open the **Set Keyframe Handle Type** menu, and select **Vector**.

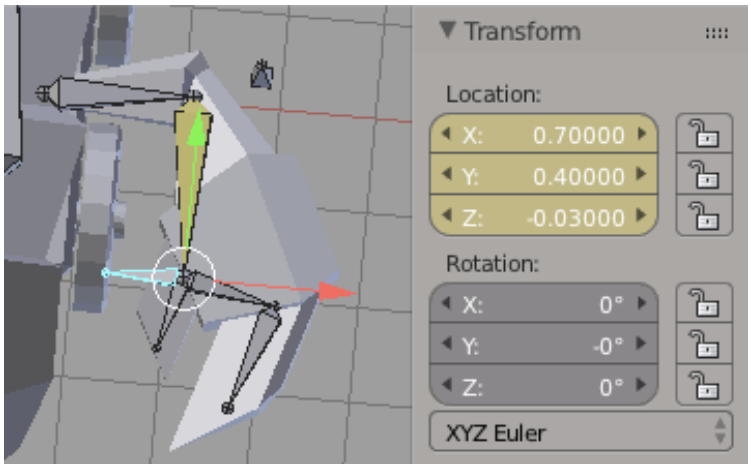


Convert all three keyframes at frame 40 to **Vector**, and adjust their handles to look like this:



Press **Alt-A** to preview your animation. Much better! The elbow draws back, has a short pause, then strikes forward swiftly. One thing that could use some adjustment is the animation *after* the strike. Right now, it doesn't look like it bounces off, or recoils, after hitting its target.

Move the playhead to frame 50 and set the following keyframe:



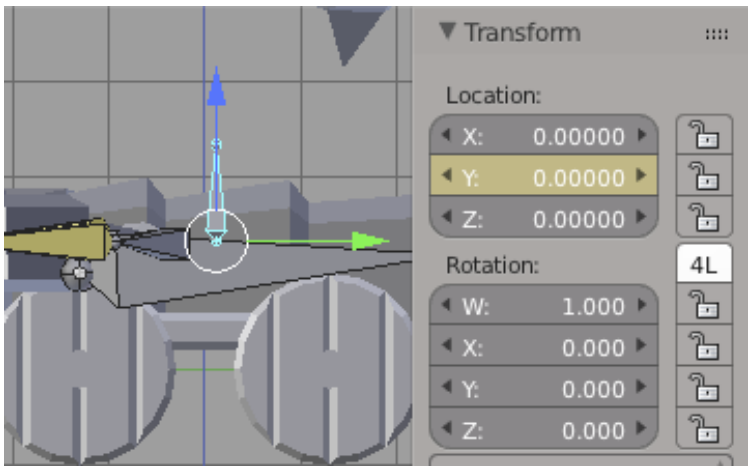
Press **Alt-A** to preview. Now the animation feels much more natural.

> **Note:** This is a good method for creating an animation. Start by keying the basic outline of the animation first, then add keyframes where necessary, to add extra movement details.

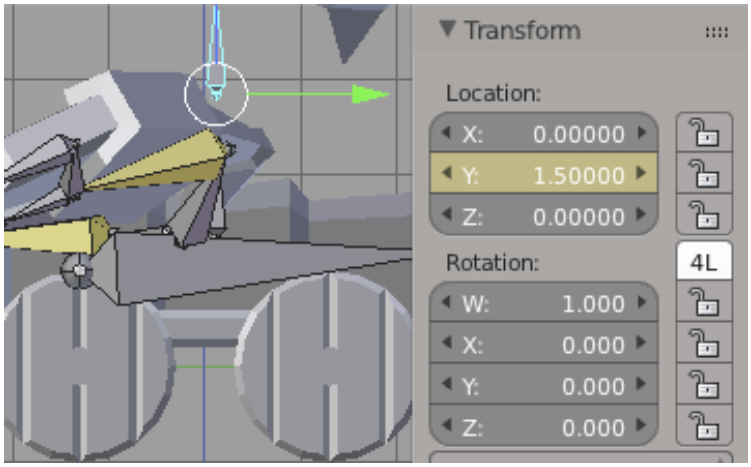
Adjusting the Pole Target to raise the elbow

The claw attack animation is almost complete. Using the Pole Target will allow you to raise the elbow, so that the arm comes up, and strikes down from above. Select the **Elbow.L** pole target bone.

1. Move the playhead to **frame zero**. The Pole Target will only move up and down, so right-click the **Location: Y** field and select **Insert Single Keyframe**.



2. Move the playhead to **frame 20**. Change the **Location: Y** field to **1.5**, right-click it, and select **Insert Single Keyframe**.



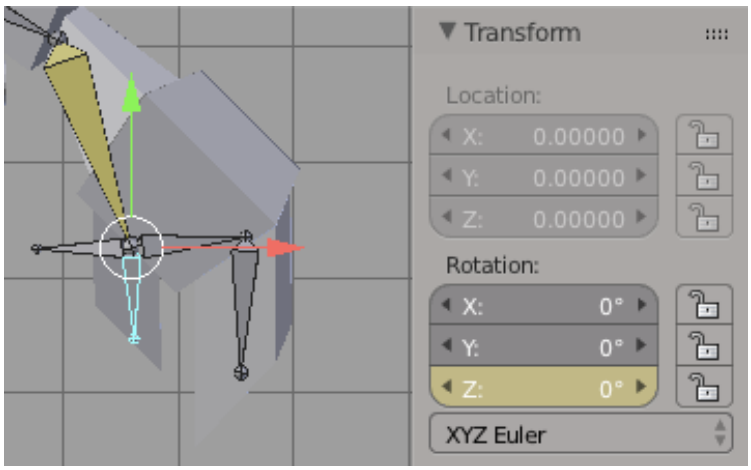
3. Move the playhead to **frame 65** and create a keyframe setting the **Y** value back to zero.

Preview the animation and orbit around it while it's playing. Now the elbow comes up nicely, as the arm is pulled back.

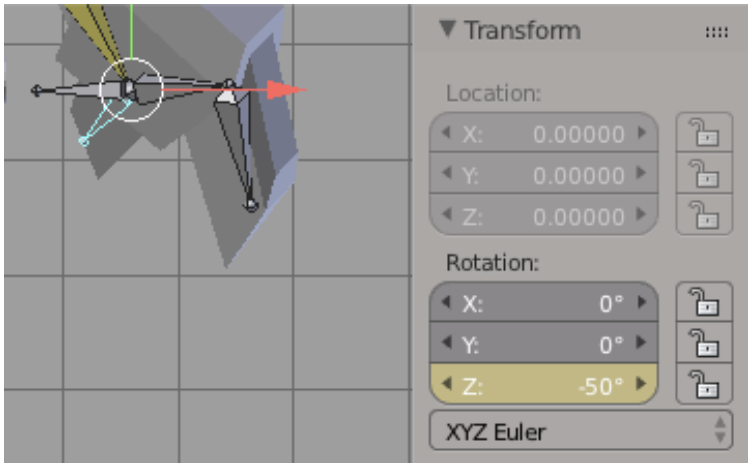
Opening the claws using Forward Kinematics

For the claws, instead of moving an object that they are aimed at, simply rotate them. This is called Forward Kinematics.

1. Move the playhead to frame 0 then select the **Thumb.L** bone. Look in the Properties shelf, ensure the **Rotation Mode** popup is set to **XYZ Euler**, then right-click the **Z** value and create a single keyframe of **0**.

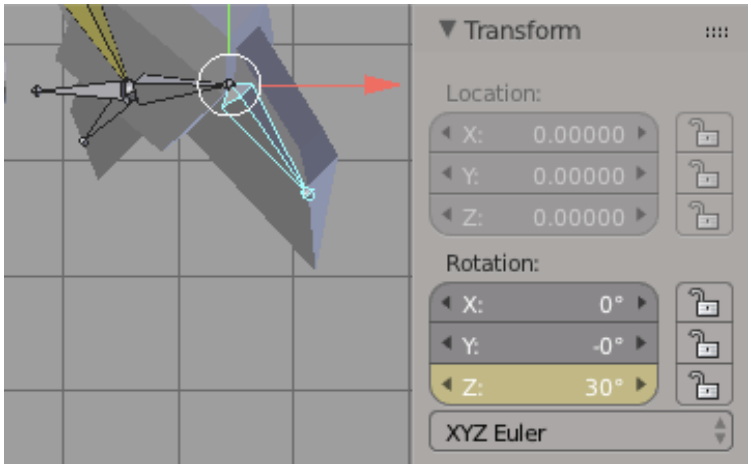


2. Move the playhead to frame **20** and change the **Z Rotation** to **-50**. Don't forget to right-click and select **Insert Single Keyframe**.



3. Move the playhead to frame **40** and set a keyframe with the **Z Rotation** back to **0** (remember that you could also duplicate the keyframe at frame zero in the Dope Sheet and move it to frame 40).

Repeat this process for the **Claw** bone. At frame **20** for this bone, set the **Z Rotation** to **30**:



Preview your animation; the claw animation is nearly complete. The keyframes are all set; the only thing that could be better is the speed. The animation feels a bit slow right now.

Scaling keyframes in the Dope Sheet

Selecting some keyframes and squashing or stretching them on the timeline is very simple, using the **Scale** tool. One important thing to note is that the point in time that it *scales from* is the playhead position.

1. Move your playhead to frame zero and press **A** to Select All. Press **S** to **Scale**:

2. Drag your cursor toward the playhead to compress the timing for the selected keyframes. Scale it until the last keyframes are on frame **40**, and **left-click** when you're finished.

This is a very easy way to speed up or slow down the timing of multiple keyframes. Just remember to move the playhead to the keyframe that should remain unchanged, before scaling.

Copying the animation to the other arm

If you want your scorpion to be able to give the ol' one-two punch, the animation you just created needs to be copied to the right arm.

1. In the **Dope Sheet**, make sure the **Claw Attack.L** action is selected, and press the **+** button next to the action name to duplicate it. Rename the new one **Claw Attack.R**. Don't forget to click the **F** button.
2. In the **3D View**, select the **Arm IK Target.L** bone.
3. In the **Graph Editor**, if your points aren't selected, press **A** to Select All.
4. With the cursor over the Graph Editor, press **Ctrl-C** to copy the animation curves.
5. In the **3D View**, select the **Arm IK Target.R** bone.
6. Make sure the playhead is at frame 0, then, in the **Properties** panel, right-click one of the **Location** fields and select **Insert Keyframes**. The X, Y and Z Location channels will appear in the graph editor for the **Arm IK Target.R** object.
7. In the **GraphEditor**, press **Ctrl-V** to paste the animation data.

> **Note:** In my experience, the animation does not always look exactly mirrored, so you may need to play with the keyframes a bit if you want them to be exactly the same. When animating a living creature, it's OK if each arm is not exactly the same.

This process will need to be repeated for each object. Take note of the channel(s) you are animating, and create an empty keyframe in that channel, so that you have somewhere to paste the animation.

Don't forget to double-check the **XYZ Rotation Order** popup when doing the Thumb and Claw bones – they need to be set to **XYZ Euler**.

Once you paste the rotation values for the thumb, you'll see that it's rotating in the opposite direction to how it should be. To fix this:

1. Move the playhead to the frame with the appropriate keyframe (if you scaled this animation the same as I did, it should be frame 12).
2. Select the **Thumb.R** bone in the 3D View. In the Properties panel, change the **Z Rotation** value from **-50** to **50**.
3. **Right-click** on the field and select **Replace Single Keyframe**.

> **Note:** Any time you change a keyed value, you *need* to use **Replace Single Keyframe** to update the keyframe itself. If you do not, your change will be removed as soon as you move the playhead.

Once you have the animation working for the right arm, be sure to use **B** to **Box Select** all the keyframes for the left arm, and press **X**, followed by **Delete Keyframes** in the Dope Sheet to remove them from the Claw Attack.R action.

> **Note:** Don't forget to save. If you'd like to see Blender file at this point, find **03-Scorpion-Animated.blend** in the Resources folder.

Where to go from here?

Congratulations! You've learned how to rig a character and create animations in Blender. I hope you had fun, and can see the potential for all kinds of character animations and object movement that you can use in your games.

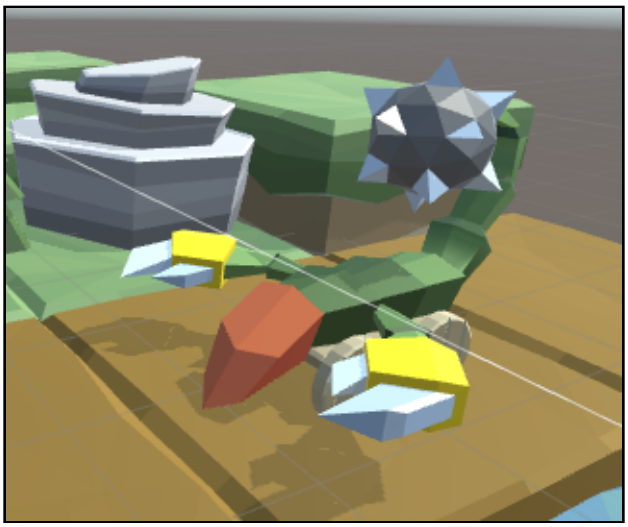
So far you've learned:

- **How to rig a model** using bones.
- **How to apply a mesh to a rig** so that it moves when the bones move.
- **How to use Inverse Kinematics** to make animations easier and more natural.
- **How to use Pole Targets** to aim a bone at specified object.
- **How to animate an armature** using keyframes and the Dope Sheet
- **How to adjust animation tweens** to create smooth or sharp animations using the Graph Editor.
- **How to create multiple animations** for a single armature using Actions, for use in Unity.

Try creating a separate **Tail Smash** Action, where the tail takes a swing and smashes to the ground; or a **Victory Dance** Action using the arms.

Once you've completed the scorpion, read the chapters on creating a tower defense game, then import the scorpion into the game. You can do this by simply dragging the blender file into Unity. Once in Unity, you may have to texture it.

This involves creating a new material, assigning the **scorpion.png** to the **Albedo** property, and adding the material to various parts of the model. For a refresher on this, read "Chapter 2: GameObjects" and look under the **Fixing the Models** section.



3D animation is a lot of fun; I hope you can use what you've learned to add life to your games in ways you couldn't before.

Summary of keyboard commands

- **Ctrl-P** - Set Parent
- **Alt-P** - Clear Parent
- **Shift-Ctrl-C** - Add Constraint (with Targets)\Tracking\Inverse Kinematics *(you must be in Pose Mode for this)*
- **Alt-A** - Play animation
- **B** - Box Select