Blender 3D Incredible Machines

Blender 3D is one of the top pieces of 3D animation software. Machine modeling is a vital part of war games, racing games, and animated action films. As the Blender software grows more powerful and popular, there is a demand to take your modeling skills to the next level.

Using this book, you will create many types of projects, including a pistol, a spacecraft, a robot, and a racecar. We start by making a sci-fi pistol, creating its basic shape and adding details to it. Moving on, you'll discover modeling methods for larger objects, such as a spacecraft, as well as the different techniques required for freestyle modeling. Then, we'll create basic shapes for the robot, unite the meshes to create unified objects, and explore the various options for freestyle rendering. We'll discuss techniques to build low poly models, create a low poly racer, and see how they differ from the high poly models we have created.

By the end of this book, you will master a workflow that you will be able to apply to your own creations.

Who this book is written for

This book is for consumers and hobbyists who use Blender 3D and want to expand their capability by diving into machine modeling with Blender 3D. You are expected to have experience with basic Blender operations.

What you will learn from this book

- Reacquaint yourself with Blender's modeling toolset
- Practice the fundamental skills that are applicable to a range of modeling projects
- Learn when and where to use various types of geometry—something that saves time in one instance will pose significant problems in another
- Think ahead and plan your project out to significantly improve both quality and efficiency
- Create models for freestyle use
- Overcome challenging modeling problems
- Create customized game models that can easily be exported to other formats. This is one of the most popular uses of Blender, and the results can be incorporated into game design!
- Get comfortable with the start-to-finish process of creating any type of hard surface model

Christopher Kuhn


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Blender 3D Incredible Machines
Design, model, and texture complex mechanical objects in Blender

Christopher Kuhn

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In this package, you will find:

- The author biography
- A preview chapter from the book, Chapter 1 'Sci-Fi Pistol - Creating the Basic Shapes'
- A synopsis of the book’s content
- More information on Blender 3D Incredible Machines
Christopher Kuhn is a 3D artist and Blender enthusiast. He has been heavily involved in the Blender community since 2010. His company, Kuhn Industries LLC, creates custom 3D assets and educational materials for both professional and non professional uses. In addition to his 3D courses on CGCookie.com, he's written two previous books on Blender (Build Your Own Rocket Bike and Death to the Armatures).
Welcome to Blender 3D Incredible Machines. In this book, we're going to explore the world of hard-surface modeling in Blender. This is distinct from organic modeling (creating humans/animals, and more), and there are different methods that we can employ to get the best results. We'll focus on ways to create complex machinery, vehicles, and other similar models in Blender.

What this book covers

Chapter 1, Sci-Fi Pistol – Creating the Basic Shapes, covers the basic modeling tools as we start our first project. It should be a good refresher for more experienced users, and will set the groundwork for more advanced modeling projects.

Chapter 2, Sci-Fi Pistol – Adding Details, looks at specific modeling techniques for adding detail to hard surface models. These techniques will be used to finish building our gun model, but will be applicable to many other projects as well.

Chapter 3, Texturing and Rendering Your Sci-Fi Pistol, takes a look at the Cycles rendering engine and how to create basic materials for it. We'll also set up a basic render scene that we can use in the future.

Chapter 4, Spacecraft – Creating the Basic Shapes, begins a more complex modeling project—a Sci-Fi spacecraft. We'll focus more on general technique and workflow here, since we covered a lot of the basic tools already in the first two chapters.

Chapter 5, Spacecraft – Adding Details, focuses heavily on detail-oriented modeling techniques. We'll look at important considerations when adding detail to a model as well as a number of tools and procedures for doing so.

Chapter 6, Spacecraft – Materials, Textures, and Rendering, builds on the techniques from our last project. We'll create a number of different materials for our spacecraft. We'll also briefly cover UV mapping and managing materials slots.

Chapter 7, Modeling Your Freestyle Robot, looks at modeling for a specific type of rendering—FreeStyle. There are a number of special modeling techniques we'll want to use to get the best possible results.
Chapter 8, *Robot – Freestyle Rendering*, looks at the specifics of FreeStyle rendering. We'll also cover the creation on non-photorealistic (NPR) rendering in the Blender Internal render engine.

Chapter 9, *Low-Poly Racer – Building the Mesh*, takes a look at one of the more common uses of Blender—building game models. We'll explore how these models are different from the ones we've already done and what specific techniques we should use (and avoid) when we do it.

Chapter 10, *Low-Poly Racer – Materials and Textures*, covers the creation of materials and textures for our low-poly game model. We'll cover UV maps more extensively, and see how we can use them to create a more universal form of textures. This will allow our game assets to be used in a variety of external applications.
1

Sci-Fi Pistol - Creating the Basic Shapes

In this section, we'll cover a few introductory topics, discuss our goals for the project, and then create the basic shape of a pistol. As we do this, we'll use a number of different tools and modifiers. At the end of this section, we'll be ready to move on and detail our pistol:

- A project overview
- Creating the barrel
- Modeling a handgrip and other pieces

Welcome to *Blender 3D Incredible Machines*.

In this book, we'll be working through a series of Blender projects aimed at increasing your modeling, texturing, and rendering skills.

Before we jump right into it, there are a few quick things that we need to cover.

First of all, I should mention that this book isn't meant for absolute beginners.

It would be great if a single volume could take you from knowing nothing about the software to cranking out sophisticated 3D models; unfortunately, this is not realistic. Blender's an incredible piece of software, but it's also complex. The sheer number of features means that learning to use it (or at least, learning to use it *well*) is a long-term endeavor. The best Blender modelers in the world will tell you that they always discover something new.

So, who exactly is the target audience?
In terms of skill level, this book will be most useful to intermediate users. Among other things, an intermediate user can do the following:

- Navigate comfortably in 3D space
- Switch between different views
- Add objects to a scene
- Move, rotate, and scale objects
- Open, close, and save files
- Switch between the Object and Edit modes
- Switch between face, edge, and vertex selections
- Add modifiers
- Drink large quantities of coffee

This book is called *Blender 3D Incredible Machines* for a reason. We're going to focus on building sophisticated mechanical models here, which means that invariably, there are certain topics that we won't cover.

There's nothing in here about creating realistic fur or setting up materials to simulate human skin. While these are fascinating topics, they're beyond the scope of this book (and frankly, I don't feel qualified to teach you about them).

As you get started with our first project, you'll find that the instructions are detailed and specific. However, as we move further along, this will become less true. This avoids repetition and also allows us to pull back and see the big picture. We can start focusing on workflow and project management, which is critical when building complex models.

There's one last thing I'd like to mention before we jump into it. In a lot of Blender tutorials, you build models based on reference or background images. This is incredibly useful when you model a real object, but everything in this book is fictional. We want to focus on technique and workflow here and leave ourselves some flexibility on the designs. Therefore, we're going to build everything in a freehand manner. However, if you'd prefer to work from a reference image, blueprints for all the models are provided at the back of this book.

This pretty much wraps up our introductory topics...so, if you're ready, let's get to work!

### A project overview

For our first project, we'll be modeling a high poly, sci-fi weapon. It's approximately the same shape as a modern day handgun, but it gives us the flexibility to be creative and explore different modeling techniques.
Here's an example of what the final model will look like (without materials and textures):

In this first chapter, we'll create the basic beveled shapes of our gun. We'll start by extruding some basic shapes. Next, we'll add the main body of the gun, then move on to the additional pieces. As we do this, we'll look at a number of modifiers and mesh tools. Specifically, we'll be discussing the following topics:

- Extrusion
- Face Normals
- Tris, Quads, and N-Gons
- Smooth versus flat shading
- The Mirror Modifier
- The Edge Split Modifier
- The knife tool
- The bevel tool

When we're finished with this section, our project will look like this:

If you're ready, let's open a new scene in Blender and get started!
Creating the barrel

We'll start by adding a circle to our scene (press Shift + A to access the Add menu). By default, circles are added with 32 sides (and 32 vertices). This screenshot will work just fine for us:

Next, we'll rotate the circle by 90° on the X axis (R, 90, X, and Enter). Then, we'll apply our rotation and scale by pressing Ctrl + A and selecting Rotation & Scale. We want to apply the rotation here for Blender to be aware of the object's default orientation. This is relevant to several tools and modifiers that we'll be using. We need to apply the scale for the same reason. For instance, the Bevel tool often doesn't work properly when objects do not have their scale values applied. We'll discuss this in detail in the later sections. For now, go ahead and apply your rotation and scale to the circle as shown here:
Now, we'll switch to the **Front** view with 1 on the numpad. We'll then go into **Edit mode** by hitting the *Tab* key. Switch to **Vertex** selection mode by using *Ctrl + Tab*:

Next, we'll use *Shift + D* to duplicate them. We'll scale the new circle down using the *S* key and drag the cursor to the middle of the circle. This smaller circle will form the inside of the barrel and allow us to make changes to the outer circle without losing track of the center (and vertices) of the original one.

Next, we'll start deleting some vertices that we don't want. The outside of the barrel will not be a perfect circle, so we'll need to change it. First, we'll delete three vertices at both the top and bottom of the circle. To do this, we'll select the ones that we don't want any longer, and then hit *X*. From the pop-up menu, select **Vertices**. This will give you a good idea of how much of the original circle is remaining. You can select more or fewer vertices depending on the desired look.
Next, we'll delete half of both the circles:

This will allow us to add the Mirror modifier. This modifier will duplicate half of an object across its axis. Using it, we can model one side of the gun, and Blender will automatically fill in the other side to match it. Obviously, this will save us a lot of time. In order to do this, go to the **Modifiers** tab of your properties panel and select **Mirror**.
At this point, it's important to select the proper axis. A few steps back, we applied rotation and scale to the circle. This is an example of why this is important—we want the object coordinates (in Blender's 3D space) to match the axis that's listed on the mirror modifier. In this particular case, it may not have mattered (since we're mirroring across the same axis that we rotated on). In general, however, this is a good habit to get into. So, let's go ahead and select the X axis on the mirror modifier. At this point, we'll also want to enable the Clipping feature. This will ensure that our vertices do not cross the centerline of an object:
So, let's go ahead and select these options:

Now that we've done this, we'll be able to work on just one side of the object. So, let's start making changes to the mesh. I'm going to grab the innermost vertex at the top of our circle and extrude it upon the Z axis by pressing E and Z and hitting Enter when we've finished extruding.

If you don't specify an axis, you'll be able to extrude (and move) this vertex in all three dimensions, which we definitely don't want to do here. So, we'll just continue to extrude vertices and move them until we have a rough shape for the cross-section of our barrel.
Obviously, there's a lot of room to personalize the model at this point—you don't need to follow these pictures exactly:

Once you have the cross-section that you're looking for, it's time to fill in some faces. It's not strictly necessary to do this right now (we'll actually end up deleting these), but it will enable us to see how Blender handles pre-existing faces during mesh editing. So, let's pick two edges at the top of our circle and create a face with the $F$ key.

This is one way to create faces (individually). We can create a series of faces from two sets of edges. In this next example, we'll select two sets of four edges and automatically fill them in. To do this, use $Ctrl +$ and **Bridge Edge Loops**.
As soon as we do this, there's a good chance that you'll have a problem. Some of the faces will appear darker than others, which indicates that the **normals** are inverted. In Blender (and other 3D applications), a normal is the vector perpendicular to your face or the direction that your face is “pointing” at. When normals are inverted, they can cause all types of problems with your model. Lines that should be smooth may end up looking sharp, and materials and textures may not work properly. In older versions of Blender, there were no visual indications (by default), and your faces were inverted. However, in newer versions, faces appear darker when you look at the “bottom” or “inside” area, and they appear lighter when you look at the “top” or “outside” area. You can also pull up your shelf with the N key, and select **Normals** under **Mesh Display**. This will produce a series of lines, which show you the direction your faces are “pointing” at. In this example, the series of faces that I just created point in the wrong direction:
Blender does have a tool for automatically correcting normals. When you select all the faces with the A key and press Ctrl + N, Blender attempts to calculate the proper direction of the faces and flips the incorrect ones. Unfortunately, this doesn't work very well with 2D shapes. Since we just have a 2D cross section of our gun barrel right now, we'll leave this step for later.

For now, let's go through and fill in the rest of our faces. All of the faces that we've created this far are known as **quads**, meaning that they're four-sided faces. However, you can also have **tris** (or triangles) and N-Gons, which are faces with more than four edges. There are advantages and disadvantages to using N-Gons, and we'll look at this later on in the modeling process. For now, you can just create an N-Gon by selecting a ring of edges and hitting the F key.

Once all your faces are filled in, you can select all of them with A key and extrude them with the E key. By default, the faces will extrude along the Y axis, which is exactly where we want them to go. In some cases, however, the faces will extrude along an axis that you don't want them to. To fix this, you can specify the axis (as we did previously with the vertices). In this case, press E and Y to extrude the faces back on the Y axis. At this point, you can drag the faces back as far as you'd like to create the gun barrel.
As you do so, you'll see more faces with incorrect normals. At this point, however, we have a real 3D object, so Blender will be able to recalculate our normals properly. Select the entire mesh again and hit Ctrl + N. All of your faces will instantly point in the correct direction.

Now, let's move to our side view (numpad 3).
The front of our barrel will be angled, so we'll use the knife tool to cut across our existing mesh to create this slant. To activate the knife tool, press Shift + K (or K then Z to cut through the entire mesh). Move the knife at the top-left corner of the barrel, and anchor it with the left mouse button. Then, drag the knife down across your faces until you have the angle that you want. Press the left mouse button again and hit Enter. At this point, you have cut a new set of edges into your mesh.

However, we're not done yet. With our new edges still selected, press the V key to rip them apart. This creates duplicate vertices that sit at the top of each other, “ripping” the mesh apart. You can move one set of vertices away from the other on the Y axis if you'd like; it makes things easier to see. You can also hit Esc immediately after ripping it apart.
Next, we'll select one vertex in our front section of the barrel (the piece we don't want). By pressing \textit{Ctrl} + \textit{L}, Blender will automatically select all the linked (connected) vertices. You can then delete them, leaving just the section that you want.
Next, we'll fill in faces at the front of the gun barrel again. Use a combination of quads and N-Gons to do this, so we can take a look at how each one is affected by the next step in our modeling process.

First, we'll add an Edge Split modifier to the gun. Most mechanical objects contain both smooth and sharp edges. Using the Edge Split modifier, we can tell Blender which angles should be sharp and which should be smooth. It's an incredibly useful tool for creating machines in Blender. To add it, just go back to your Modifier and select Edge Split.
Once you add the modifier, go ahead and hit **Smooth** on the toolbar at the left-hand side of the screen. This will tell Blender that the entire object should use smooth shading except where the Edge Split modifier tells it not to. In this case, any angle that is greater than (or equal to) 30° will show up as **Flat** (sharp). Any angle less than this will show up as smooth. You can see the difference between smooth and flat shading in the upcoming picture.

By changing the **Split Angle** within the modifier, you're telling Blender which angles should be smooth and which should be sharp. There are times you'll want to change this number, but the default angle of 30° is actually very good most of the time. So, we'll leave this in place.
Now that we've got this taken care of, we'll smooth out our gun barrel a little bit. To do this, we'll use the Bevel tool. First, select the edges that you'd like to smooth out, then press W and select Bevel to activate the tool. Alternatively, you can activate the tool by pressing Ctrl + B.

With the tool activated, you can drag the mouse across the screen to change the amount of beveling on an edge. By rolling the mouse wheel, you will increase the number of segments to the bevel. If you want a sharp edge (like the corner of a piece of metal) it's best to just use one segment. If you're trying to create smooth curves, you can roll the mouse wheel up until the curve is sufficiently smooth. By selecting different edges on the gun barrel, you can smooth out the overall shape.
As we look at the front of the gun, we notice an interesting problem. Actually, it's not a problem; it's just the way that Blender does beveling. This is why we've filled in these faces at the front of the barrel, so we could observe the effects of the bevel tool on different types of faces. Here, you can see one of the key advantages of an N-Gon. It will not become distorted by the beveling process. This is not true for QUADs and TRIs:
These faces on the front of the barrel will technically work, but they look a bit messy. If you want to clean things up, you can quickly select all the faces you want to keep, then press Ctrl + I. This is known as the select inverse function, and it does exactly what the name implies.

Next, you can just delete the faces with the X key. Then, select the edge loops that form the front of the barrel and press F. This will automatically fill in a single N-Gon on the front of the barrel.

Next, we'll use the Bevel tool again to just slightly bevel the front edges of the barrel. Since there are no perfect angles in nature, this is a very common way to establish a bit of realism for mechanical models.
When you've done this, just select the two edge loops that make up the barrel and press Ctrl + E and Mark Sharp. The angles will show up as sharp anyway (since they probably exceed 30°), but if you know that you want an edge to be sharp, it never hurts to mark it that way. You may make changes down the line that affect an edge's angle. This way, you never have to worry about it.

At this point, the basic shape of our barrel is complete. Make any final corrections that you'd like, and then we'll move on to the rest of the gun.
Modeling a handgrip and other pieces

The first thing we want to do is select the barrel again, and then press *Shift +S* and **Cursor to Selected**. This will place the 3D cursor at the origin point of our gun object. Any objects that we add after this will be automatically placed there:

Next, we’ll bring up the *Add* menu again and add a cube to our project. It will appear directly in line with the gun barrel. Depending on the scale of your barrel, the cube may appear slightly bigger or smaller than the image shown here:
Tab into the **Edit mode** and adjust the scale until it's to your liking.

Next, use `Ctrl + R` to run a **loop cut** around the outside of the cube. This will enable us to make a few changes to the shape.
You can move the loop cut up or down as you'd like. When you've finished this, you can grab various edges and move them back or forward to create the desired shape for the gun's body.

Once you've formed the basic shape that you'd like, we'll delete the front and rear faces of the gun's body. Afterwards, you can go in and bevel the edges as much (or as little) as you'd like. Again, you can use the provided image at the beginning of the chapter if you'd like, or you can modify it to make it your own.

Once you have a shape that you like, we'll go ahead and join this object to our barrel. In order to do this, we'll need to make a few changes.

First, we'll delete the very top and bottom faces of the body. Then, we'll delete one half of it (make sure to delete the same half that you did with the barrel—we want all of the mesh to be on the same side).
Then, **Tab** out to **Object** mode. Select the gun body first and then the barrel. Press \( Ctrl + J \) to join the body to the barrel.

The first object that you pick will always be joined to the second object.

Next, we'll grab the very top and bottom edges of our gun block and extrude them in toward the center (on the \( X \) axis). Since **Clipping** was selected on our **Mirror** modifier, the edges will not go past the object’s centerline.

After you've done this, select the series of small edges (from the bevel) in the middle of the gun block and extrude these into the centerline as well.
Next, we'll be filling in some faces on the back of the gun's body. We'll use a combination of N-Gons and quads to do this.

It's important to know where you can use an N-Gon and where you can't. The most important rule about N-Gons is that they must always be flat. As we look at the back of our gun's body, we can see a series of small curved edges in the middle:

![Diagram of flat and curved edges](image)

To better understand this rule, look at the following image. You can see that the portions of a sphere have been cut out and replaced with a single, curved N-Gon. The N-Gon is bending to connect various edges together. This dramatically affects both the shape and shading of your object, and it will create unwanted artifacts at render time:

![Diagram of sphere with N-Gon](image)
Going back to our gun's body, we'll fill flat edges in with N-Gons. When you're finished with this, select the outer ring of edges at the back.

We'll attempt to bevel this in the same way we did before. However, depending on the exact shape of your gun's body, you may end up with something like this:
What you’re seeing here is beveled edges that are overlapping each other. This is a fairly common occurrence with the bevel tool. When it happens, the best fix is to change the geometry a little bit. In this case, we'll remove the bottom N-Gon first. Then, we can extrude a series of small edges across, towards the middle. Once you've done this, you can fill the holes back in and re-bevel them:

Repeat these steps with the front of the body as well.

At this point, we've covered all of the key topics for this chapter. Using the same methods that we've just looked at, you can now go through and create basic shapes for the rest of body. The following image is just a sample; feel free to use your imagination here!
When you've got basic shapes added and beveled, the result will look something like this:

Make sure that all of your different meshes are a part of the same object (the original barrel). When you're finished with this, we'll be ready to move on to the detailing phase.

Summary
In this section, we blocked out the basic parts of our gun. We used the Mirror and Edge Split modifiers as well as a number of mesh tools. In the next section, we'll use a number of different tools, modifiers, and techniques to bring out a lot of detail. These steps will not only allow us to finish our gun, but they will be useful for the rest of our projects as well. So, let's get started!
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