

3D CAD modelling for beginners

Start printing your own designs with this phone stand modelling tutorial



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YOU'LL NEED

- ◆ **Windows, Mac, or Linux computer**
- ◆ **An internet connection**
- ◆ **Autodesk Fusion 360** (free for students or hobbyists)
- ◆ **Callipers, a measuring tape, or a ruler**
- ◆ **Access to a 3D printer** (if you'd like to print your design)

You've had that 3D printer for a little while now; it was so exciting when it showed up in the mail, chock-full of gleaming metal and possibilities, wasn't it? But, like most people, you've likely started to get bored with printing pencil holders, coasters, and figurines that you find online. Those trinkets are fun for a little while, but the real potential of your 3D printer is in printing your very own designs.

Designing your own 3D models means using CAD (computer-aided design) software. Unfortunately, CAD software has a very steep learning curve, and is difficult for beginners to get started with. After all, there are entire college degree programmes devoted to becoming proficient in CAD. But, that doesn't mean there isn't hope! Learning to use CAD is much less about where all of the individual commands are, and more about understanding the concepts involved.

In this article, you'll learn how to use those basic concepts to model your own smartphone stand. With these skills, you'll be able to design your own ideas. But, more importantly, you'll gain an understanding of how to approach 3D modelling so that you can continue to expand your knowledge. Everyone needs a starting point, and if you've been looking to get started with 3D modelling, this is it!

The first thing you'll need to do is download Autodesk Fusion 360, which can be found with a Google search. Fusion 360 is on par with professional CAD software, but is free for students and hobbyists to use. Unlike 3D sculpting programs, like Blender or Maya, parametric CAD software is intended for engineering purposes and all of the modelling is handled mathematically.

With a 3D sculpting program, you mould your design like you're working with digital clay – it's a visual process. Parametric CAD software requires that you define features with dimensions and relationships (the parameters). The benefit is twofold: the resulting model maintains the precise dimensions that you

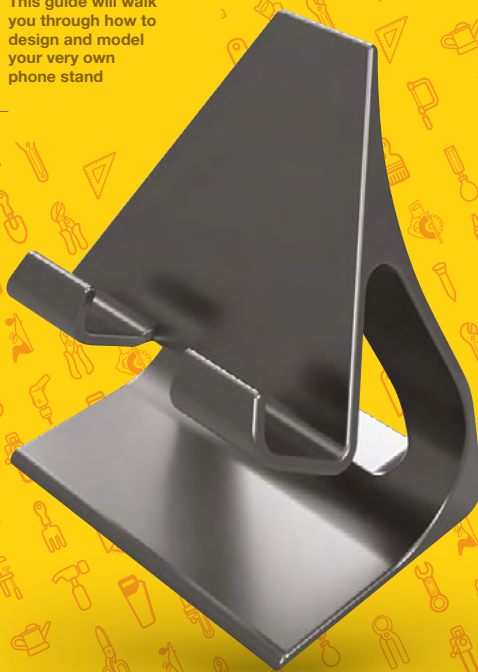
specify, and it stores the entire design history so you can modify individual features later.

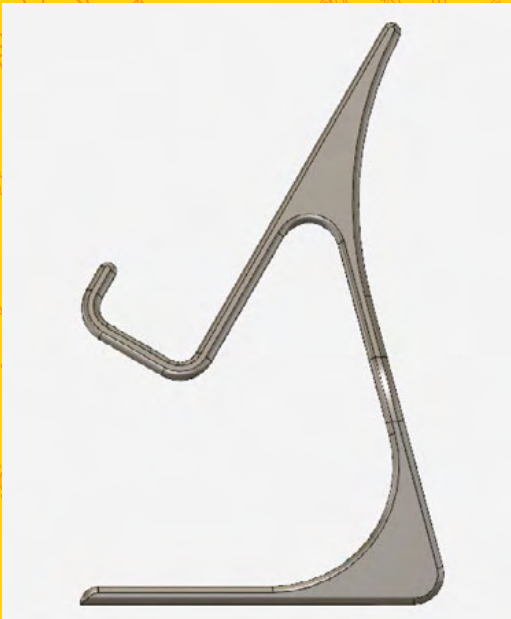
CAD LOOKS SCARY; TAKE YOUR TIME

Once you've downloaded Fusion 360, take some time to familiarise yourself with the layout of the interface. The primary part of the window is the viewport, where you'll interact with the model. The viewport is fully three-dimensional, and the model can be rotated and viewed from different angles while you're working on it. The View Cube at the top right of the viewport lets you quickly rotate the model to predefined angles.

The main toolbar along the top of the viewport contains all of the tools you'll need for modelling.

Below 
This guide will walk you through how to design and model your very own phone stand





Above When you begin modelling a new design, start by finding the angle that gives you a basic feature for your first sketch

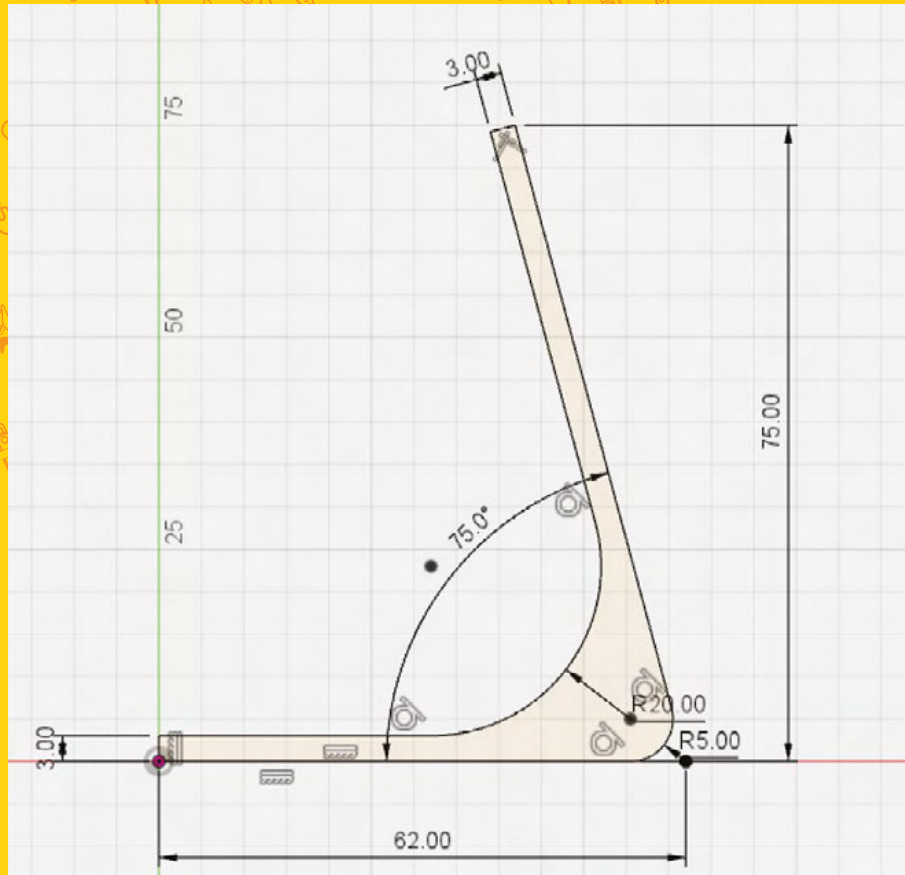
On the left-hand side of the main toolbar is a drop-down for switching workspaces. Each workspace is set up for different tasks; for instance, you use the Render workspace to set up a realistic rendering of your model for presentation purposes. You'll find everything you need for this guide in the Model workspace.

Running down the left-hand side of the viewport is the component browser, which has information and settings for units, views, and buttons for toggling object visibility. The bottom of the window will show the design history as you create features, and you can access each step to modify it. Finally, the top left-most button opens the Data Panel, where you can manage your projects and design files.

You're modelling this stand for your actual phone, so you'll need to take some measurements of it. A pair of callipers are going to give you the most accurate measurements. If you don't have callipers, a ruler or measuring tape will work. You'll need to measure the length, width, and thickness of your phone. This tutorial will use millimetres, but you can work with inches if you'd prefer.

BREAK THE DESIGN DOWN INTO PARTS

The key to CAD modelling is breaking the model down into a series of individual features. For instance, if you were modelling a cup you might make the first feature a cylinder, and use a second feature to make that cylinder hollow. While there is no right way to model something, there are some



best practices. Multiple simple features are generally better than a single complex feature, as there is less opportunity for error and the features are easier to modify later on if need be.

We'll cover a good way to break the phone stand down into a series of features. But, first try to visualise the stand as a 3D object, and consider how it can be reduced down into simple steps. Looking at the end result might make the model seem complex, but each individual feature is actually quite simple. Think of it a bit like building a LEGO set: each block is very basic, but when added together they can make an intricate design.

The first modelling step is to create an extrusion to act as the base of the model. The Extrude feature is definitely the most commonly used tool for the vast majority of designers. It takes a 2D sketch profile and give it thickness to form a 3D solid. It can also do the opposite, and cut that sketch profile out of an existing solid. If you picture the phone stand from the side, you'll notice that it has a consistent silhouette, so starting from that angle is a good idea.

KEEP SKETCHES SIMPLE

Sketching that entire silhouette, however, would make this first feature pretty complex. Instead, →

Above Keep individual sketches and features simple. Overreaching by trying to put everything in a single feature will only make the process more difficult

QUICK TIP

Often, when modelling for 3D printing, it's a good idea to take into account the need for supports and to avoid overhangs when possible.



Above Don't settle for just 'functional' in your designs. Take the time to give it some finishing touches to make it look good!

THE ORIGIN

A number of predefined references are automatically created when you start a new model. The centre of all of these is the Origin, which everything else references. The X, Y, and Z axes all intersect at the Origin, and three planes are created by these axes. In Fusion 360 the XY plane is usually called the Front plane, the XZ plane is called the Top plane, and the YZ plane is the side (or right/left) plane. These correspond to the views named on the View Cube.

start with only the base of the stand and the upright support. Click the Create Sketch button from the main toolbar, and select YZ (side) plane as the sketch plane. Then, use the drawing tools under the Sketch menu to draw lines to form the outline of this first feature. Both the base and upright should be 3mm thick, the base should be about 62mm long, and the upright should be about 75mm tall. The angle between the two should be roughly 75°. These dimensions can be set using the Sketch Dimension tool.

Adding fillets to the corners where the angled lines of the upright meet the horizontal lines of the base is a good idea. Fillets round those edges, making the model stronger and more professional-looking. Unless you have a reason to leave them sharp, you should round most corners and edges with fillets, or blunt them with chamfers. A fillet is defined by the radius of the arc connecting two lines, while a chamfer is defined by the length and angle of the chord.

Your sketches should always be fully defined, which means the lines can't be moved. Geometric constraints can help with this, and are in the Sketch Palette. The bottom line of the base, for example, needs to be horizontal. So, to lock that, you'll select that line and then click the Horizontal/Vertical constraint. When a line is fully constrained, it will change from blue to black. Make sure all of your lines are black before continuing, and the sketch should be constrained to the Origin point.

// Your sketches should always be fully defined, which means the lines can't be moved **//**

TRIAL AND ERROR

Almost every feature will have a dialogue box that contains a variety of options that affect the resulting 3D solid body. The most common options are the selection (like what you use to choose the sketch profile), and the primary dimension (like the distance of an extrusion). Try changing these options to see what change they make. And, if a feature ever gives you an error or acts unexpectedly, check these options to see if they fix the issue.

EXTRUDE IS A POWERFUL TOOL

Once you have completed the sketch, choose the Extrude tool from the Create menu to give it thickness. This is where the width measurement you took of your phone comes in. You'll select the closed profile that you sketched, and extrude it to match the width of your phone. It's best to make this Symmetric, so that the part is centred on the origin. Make sure the Measurement option is set to overall distance, and make the Distance equal to the width of your phone.

The next feature is an extruded cut through the upright support. This will reduce the amount of material in the final model, and adds visual appeal. The sketch for this feature needs to be perpendicular to the last one, so choose the XY (front) plane as the sketch plane. Then, draw a shape to cut out (like a triangle), making sure to leave enough material on all sides of the upright to keep it strong. When you extrude your sketch, set the operation to Cut, and make the Distance Through All.

To make the actual platform that your phone will rest on, you'll create yet another extrusion. This will be on the same plane as your first extrusion, and needs to form a J shape to hold your phone. The angle of this platform should be

around 60° from horizontal. Make the height about half the length of your phone, and the space between it and the front flip should be slightly larger than the thickness of your phone. This will allow you to easily rest your phone on the stand, while still keeping it good and secure.

The final feature, to finish the base structure, is a cut-out for your phone's charging port. Cut this out of the bottom support and lip of the platform. Sketches don't have to be on the predefined planes, and the sketch for this extruded cut can be the outer face of the lip. Simply draw a rectangle that's the same height as

the slip, make it wide enough to access the charging port, and extrude the cut to the face of the platform.

There is one more cut to consider, and that's from the platform. There is no reason to have a big, bulky rectangle for your phone to rest on. Removing material will speed up the printing process and reduce how much filament is needed. Create a sketch on the platform, and cut out the superfluous material. The shape can be whatever you'd like, so make it aesthetically pleasing to you.

AESTHETICS ARE IMPORTANT

Now add some finishing touches, which will be fillets and/or chamfers. The most important ones are where the platform meets the upright support, to give the stand rigidity and strength. When you're adding this to an existing solid, there is no need to draw a sketch. Just choose the Fillet or Chamfer tool from the Modify menu, and select the edges you want to smooth out.

For visual appeal, it's good practice to add a fillet or chamfer to any edge that doesn't need to be sharp. Breaking these edges gives the model a more finished appearance, and removes sharp edges that might be uncomfortable to handle. Keep adding fillets until you're satisfied with the overall look of your phone stand.

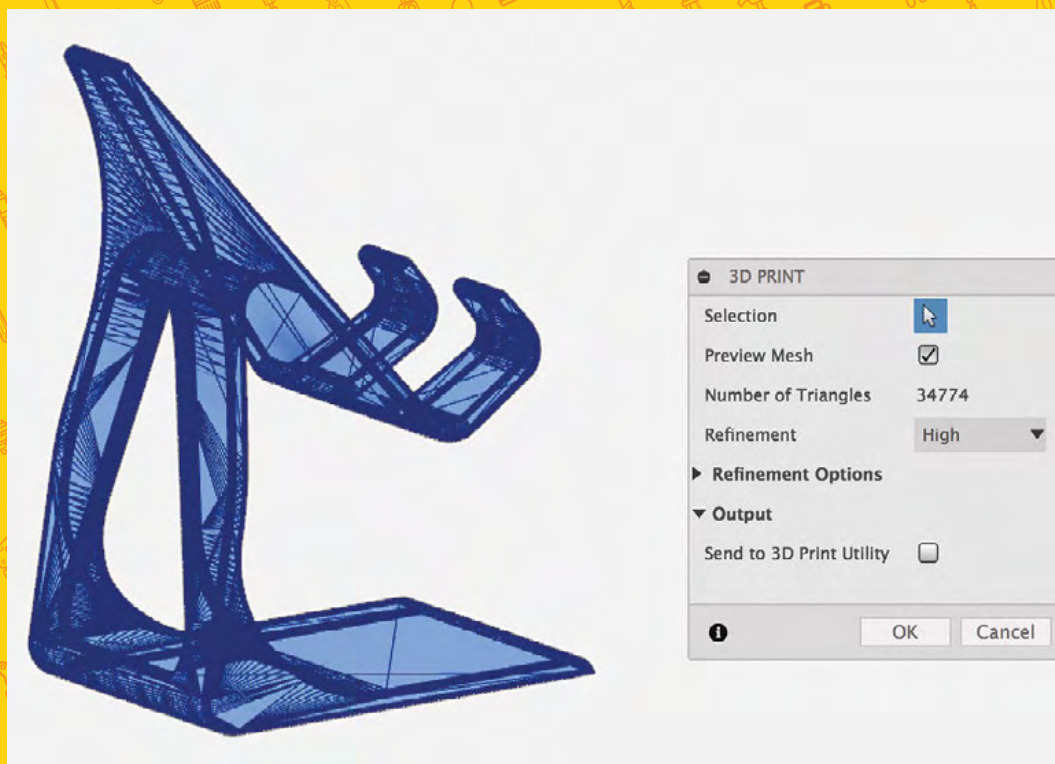
FILLETS AND CHAMFERS

The radius of a fillet (pronounced 'fill-it') cannot be larger than the space available, so if you get errors, try making the fillet smaller. A well-placed fillet can make all the difference in the perceived quality of the final design. Chamfers work well in place of fillets when a more modern and angular aesthetic is desired. Most designs will probably benefit from some combination of both fillets and chamfers.

PRINT THAT MODEL!

With the model done, you can prepare it for 3D printing. From the Make drop-down menu, click 3D Print to bring up the STL settings dialogue box. Select the model, and set the options to your liking. Unless you're trying to make the STL file small, it's a good idea to use the High settings to make the resulting STL mesh as detailed as possible. You can then either output the STL to your 3D printing software, or save it somewhere on your computer.

And that's it, you're done! While there are lots of other types of features and tools that weren't covered in this guide, you can do a great deal of modelling with what you've learned here. The next time you want to 3D-print something, try using these tools to create the model yourself! ■



QUICK TIP

Always consider how your creation will be used. For instance, you might want to add a small clip or guide to keep your charging cable in place.

Left ■ Once you're done modelling your design, saving an STL for 3D printing is trivial. For quality, keep the refinement high