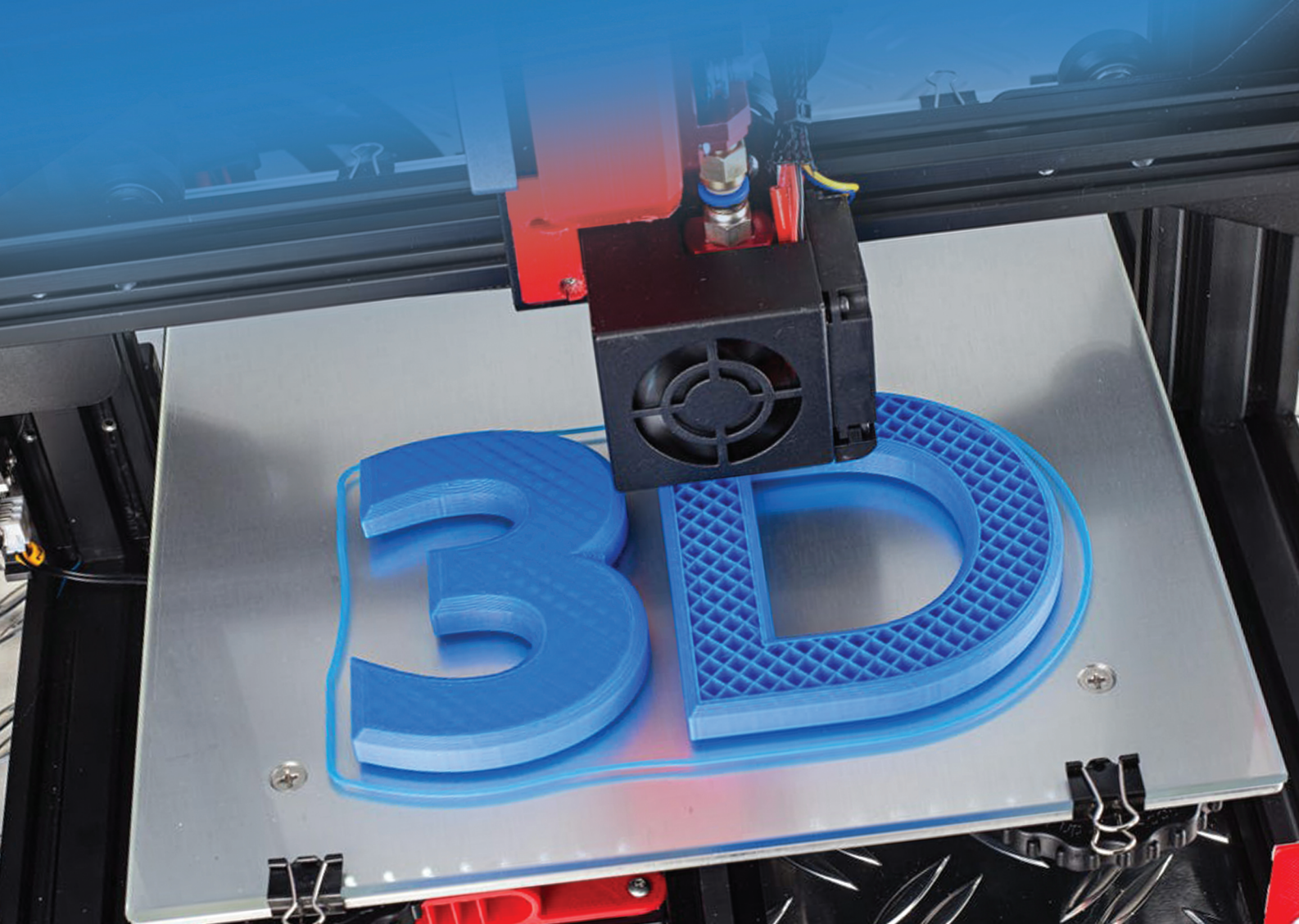
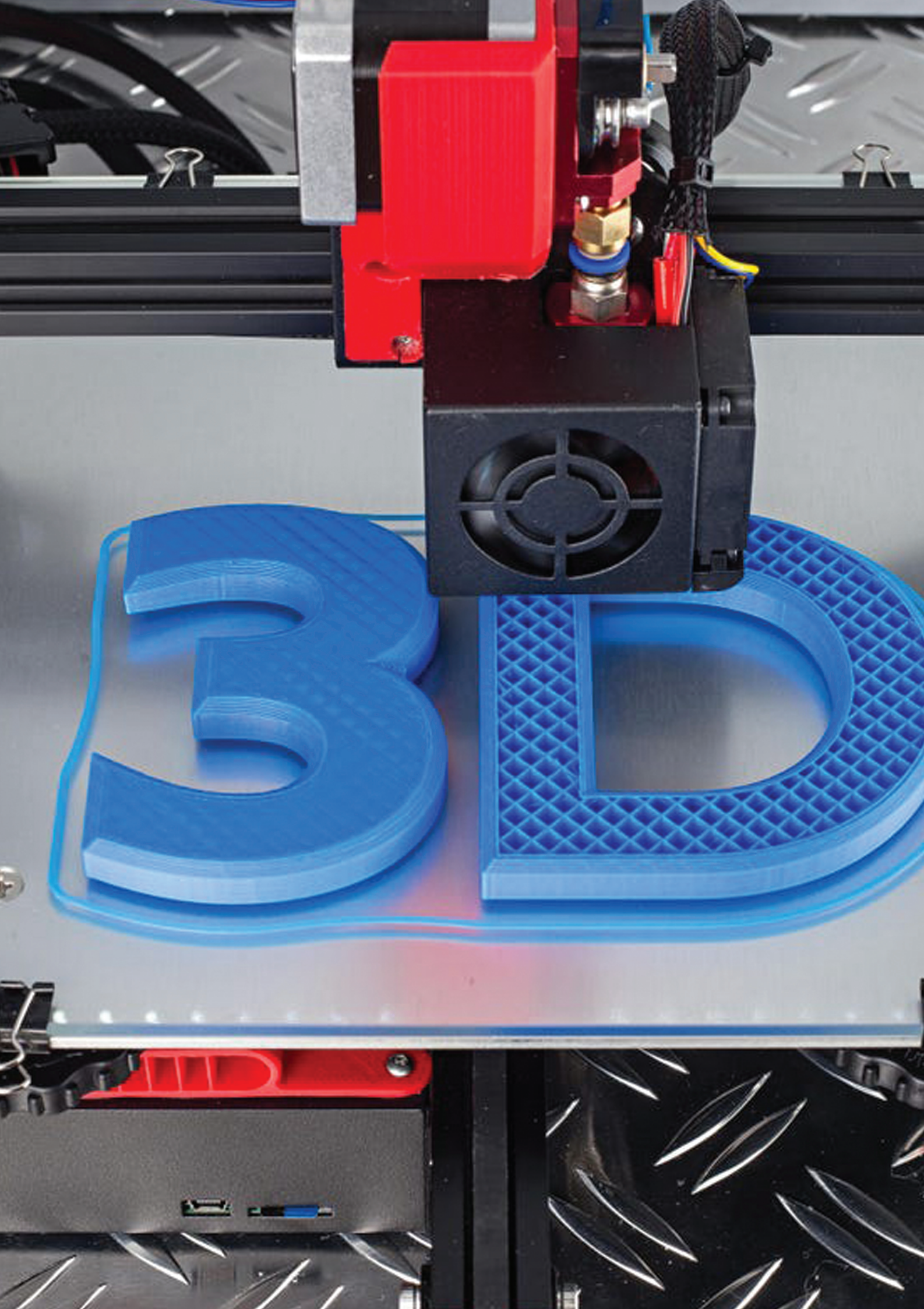
ROBOTROD
by Olatus Systems Private Limited

VOLUME 1

3-D PRINTING




3D

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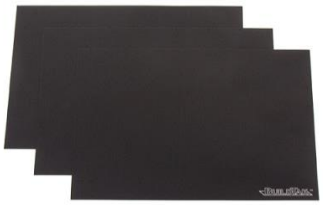
Print Bed

The print bed is the surface that your objects are printed on to. Typically, it will consist of a sheet of glass, a heating element, and some kind of surface on top to help the plastic stick.

Heated/Non-Heated

Most print beds are heated in order to prevent the object from warping while it is being printed. Due to thermal contraction, the plastic will shrink slightly as it cools. This causes the object to warp upwards around the edges and peel off the bed. Heated beds keep the bottom of the object warm, in order to prevent this. See also; Enclosure, Bed Surfaces.

Some printers do not have heated beds. This limits them to printing a narrow range of materials including mainly PLA (the material that is least prone to warping) and sometimes PET.



Bed Surfaces

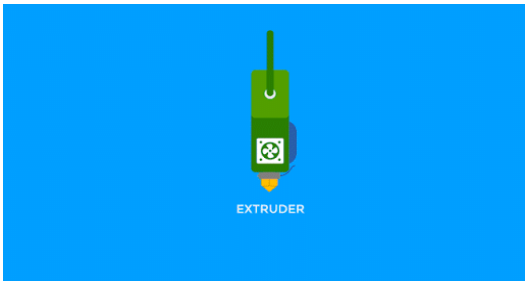
The bed surface helps the plastic stick to the bed during printing but also allows it to be removed easily when printing is done. There are many different kinds of bed surfaces. Most printers will come with some kind of all-purpose surfaces, like BuildTak or PEI film. However, for best results, you will want to use different surfaces depending on the material you are printing. Use this guide for print bed recommendations based on the material.

Filament

This is the plastic that's consumed by the printer. It comes on a spool. Printers use two different sizes of the filament, 1.75 mm and 3 mm. There are a variety of different materials. To learn more about them, check out the Matter Hackers filament guide.

Extruder

The extruder is the core of the printer. It is where the plastic gets drawn in, melted, and pushed out. It is essentially a fancy hot glue gun. It is small, but it is where most of the printer's technology is located. The extruder consists of two parts; the hot end and the cold end. The cold end has a motor that draws the filament in and pushes it through. The hot end is where the filament gets melted and squirted out.



Direct Drive Vs Bowden Extruder

- On **direct drive** printers, the hot end and cold end are connected together, one on top of the other. The filament goes straight down through the cold end and into the hot end.
- With a Bowden setup, the hot end and cold end are separated. The cold end will be stationary and bolted somewhere onto the printer's frame. The filament is pushed through a long tube (called a Bowden tube) to the hot end. This means that the printer has less weight to move around.

Hobbed Gear

This gear bites the filament and pushes it down through the hot end.

Idler Gear

The idler is a spring-loaded wheel that pushes the filament up against the hobbed gear. Most printers have a way to adjust the tension on the idler so that it neither squeezes the filament too hard or too little.

Hot End - All Metal Vs PEEK/PTFE

By not using any plastic insulators in their construction, all metal hot ends are able to reach much higher temperatures and print a wider range of materials. However, they require active cooling.

Hot End - Heat Sink / Hot End Fan

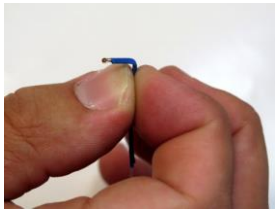
This ensures that heat does not travel up the plastic and melt it prematurely before it reaches the nozzle. This phenomenon is called heat creep and it causes jams, especially with PLA. This fan should be running whenever the hot end is warm.

Heater cartridge

The heater cartridge is pretty self-explanatory. It heats the plastic. It is simply a high-power resistor. Almost all modern printers use cartridge heaters, but many older printers used coils of nichrome wire (like the kind in a toaster). If you are replacing your heater cartridge, of even your entire hot end, make sure you know if your system is running 12v or 24v.

Thermistor/Thermocouple

These are all various types of sensors for determining the temperature of the hot end. They are essentially electronic thermometers. Thermistors are the most common type of sensor, but some printers will use thermocouples for extremely high-temperature printing.



Nozzle

The nozzle is simply a piece with a small hole for the melted filament to come out of. Nozzles are interchangeable, and come in various sizes; 0.4 mm is normal, while you might use a smaller nozzle for finer detail or a larger nozzle to print faster. Nozzles can also sometimes get clogged. This is one of the most common issues with 3D printers. See this article for advice on unclogging your nozzle.

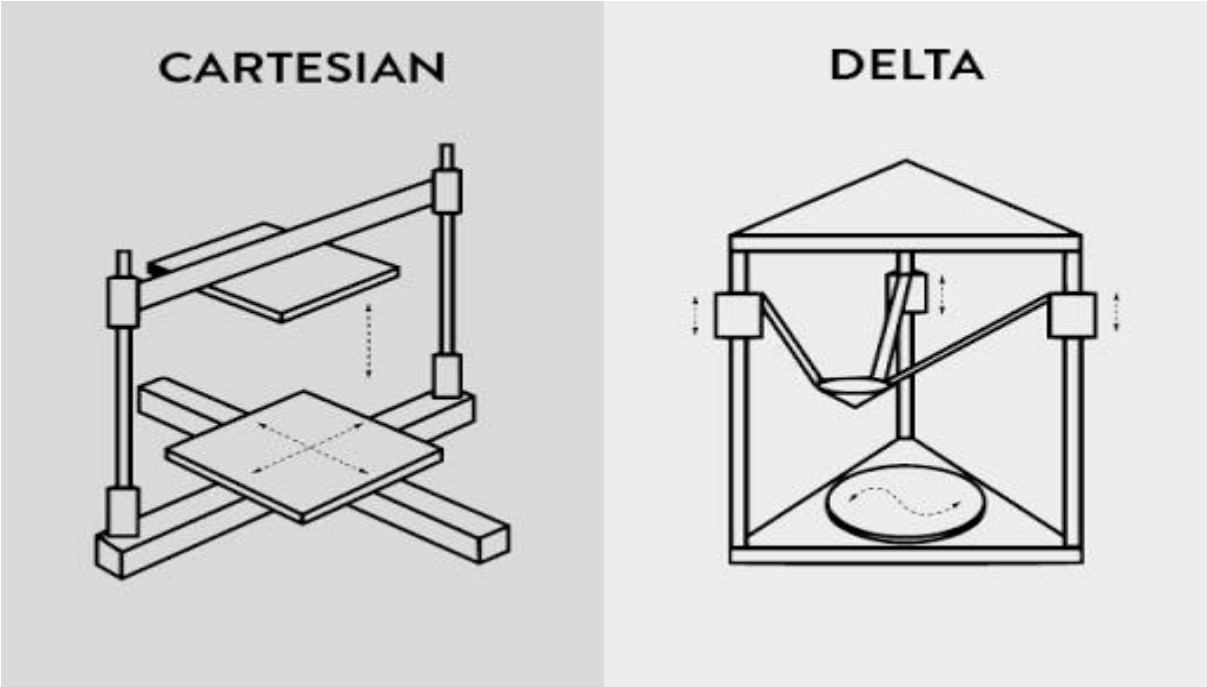
Layer Cooling Fan

This fan cools off the plastic immediately after it is deposited by the nozzle. It helps the object hold its shape. The slicer will turn this fan on and off under different circumstances, depending on what material you are printing. It is not to be confused with the heat sink fan, which cools the hot end itself and not the printed object.

Motion Control - X, Y, Z-axis:

Delta Vs Cartesian

- Cartesian printers move one or two motors along each of the X, Y, and Z axes and the name was derived from the Cartesian coordinates system. They typically have a rectangular build area and the printers themselves tend to have a cube-like shape. The Lulzbot Mini is a fine example of these types of printers.
- Delta printers have three arms that come together in the center to suspend the extruder above the build area. Deltas also use a Cartesian coordinates system to move around in, but instead of moving one motor per axis at a time, all three arms move at different rates or times to precisely move the nozzle with triangulation. The See Me CNC Rostock MAX V2 is a prime example of a delta printer.



Threaded Rods / Leadscrews

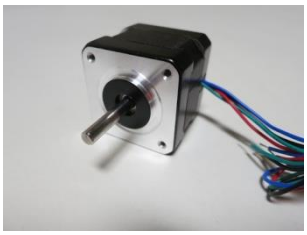
These are usually used on the printer's Z axis. They rotate, thus forcing nuts to move up and down. Inexpensive printers will use simple threaded steel rods, which are essentially extra-long bolts. Higher quality printers have smooth chrome plated lead screws designed to minimize backlash.

Belts

Belts move things. The X and Y motors have sprockets that drive the belts. Most printers also have some way of adjusting the tension on the belts.

Stepper Motors

Unlike regular DC motors, which rotate continuously when given power, stepper motors rotate in increments. This gives them precise control over their position. Most printers use NEMA 17 type motors with 200 increments (steps) per revolution.



Frame

The frame holds everything together. Early printers had frames made out of laser cut plywood. Printers now have frames made of sheet metal, aluminum beams, or plastic. Many parts of the frame are often 3D printed themselves. The more rigid the frame, the more precise the printer's movement will be.

Enclosures

Enclosures for 3D printing are used for safety. There are moving parts and heating elements that users will want to protect themselves from. If your printer does not offer an enclosure, it is easy to construct your own. Something as simple as a cardboard box could suffice.

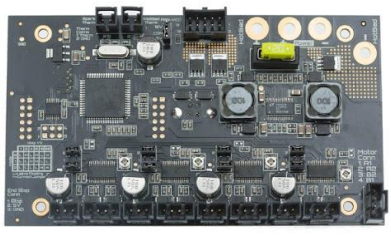
Electrical Components:

Power Supply

- This takes the 120V AC electricity from the wall and converts it to low voltage DC power for your printer to use
- **ATX Power Supplies**- These are the same power supplies used in desktop computers. They have been repurposed for use in many printers. They are very beefy and efficient and have separate lines that provide power at a variety of voltage (12V, 5V, 3.3V).
- **Voltage** - some machines run 12 volt systems, while others run 24 volt systems. This becomes critical if you are going to replace components - especially your heater cartridge or hot end. Make sure you order the appropriate parts.

Motherboard

The motherboard is the brain of the printer. It takes the commands given to it by your computer (in the form of G-Code) and orchestrates their execution. The motherboard contains a microcontroller (essentially a tiny, self-contained computer) and all the circuitry needed for running the motors, reading the sensors, and talking to your computer. Here is a comparison of the different motherboards we carry.



Stepper Drivers

These chips are responsible for running the stepper motors. They fire the coils of the motor in sequence, causing it to move in increments. Many motherboards have the stepper drivers built in, but some also have them in modules that can be unplugged. By balancing the power fed to each coil, the driver is also able to divide steps up into further increments. This is called micro stepping and allows more precise control over the motor than is normally possible. The stepper driver also controls how much electrical current is fed to the motor. More power makes the motor stronger, but also makes it run hotter. See this article for more information on adjusting your motor current.

User Interface

Some printers have an LCD screen so they can be controlled directly without hooking them up to a computer. These can be basic black and white displays like the VIKI 2 or advanced Wi-Fi-enabled touch screens like the Matter Control Touch.

SD Card Slot

Some printers also have an SD card slot from which they can load G-Code files. This allows them to run independently without a computer.

End Stops (one for each axis)

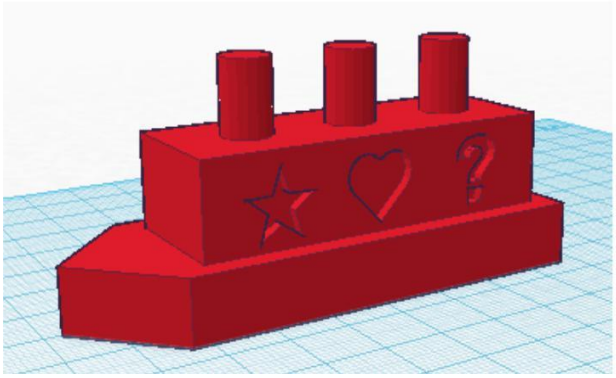
The end stops are how the printer knows where it is. They are little switches that get pushed whenever an axis moves to the end. This is how the printer finds it's starting point before printing. Most printers use mechanical switches, but some are known to use optical sensors.

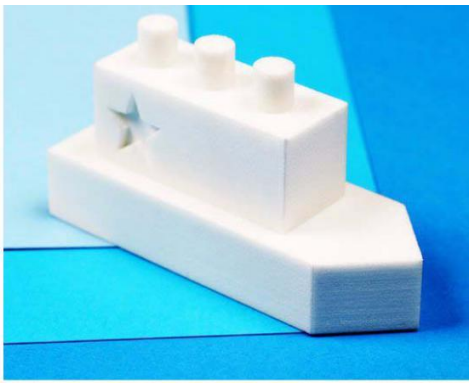
Bed Leveling

Many printers have some kind of a system for automatically making sure that the bed is level with the nozzle. Some do not, though, and must be calibrated by hand. Matter Control also has the ability to account for unevenness in software. For more information, see our wiki article on bed leveling.

Chapter 2-Getting Started in Tinkercad

Tinkercad is a fun, easy to use, web-based 3D design application. You don't need any design experience - Tinkercad can be used by anyone. In fact, kids are Tinkercad's target audience, so don't worry - this project isn't complicated! Sit back, follow the steps, and in no time, you'll be able to complete this cute little boat (shown in red below, next to a 3D printout in white, of a similar boat):

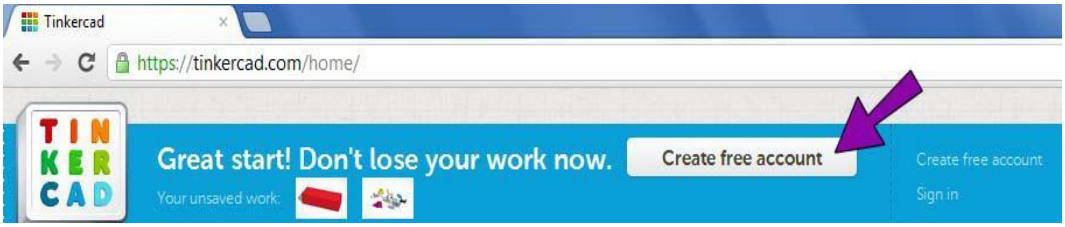




The cool thing about Tinkercad is that it's ideal for creating things that be *printed*. No, not printed on a boring and flat 2D sheet of paper! Tinkercad is made for producing *actual objects*: you can easily send your model to a 3D printer and end up with an actual object you can hold in your hand.

Have a Look Around

1. Tinkercad's website is (as you'd expect) www.tinkercad.com. All work is done and saved on the web; there's nothing to install onto your computer. You don't need a Tinkercad account to design things, but it's free to set one up, and with an account, you get to save your work. So, there's no reason not to create an account.

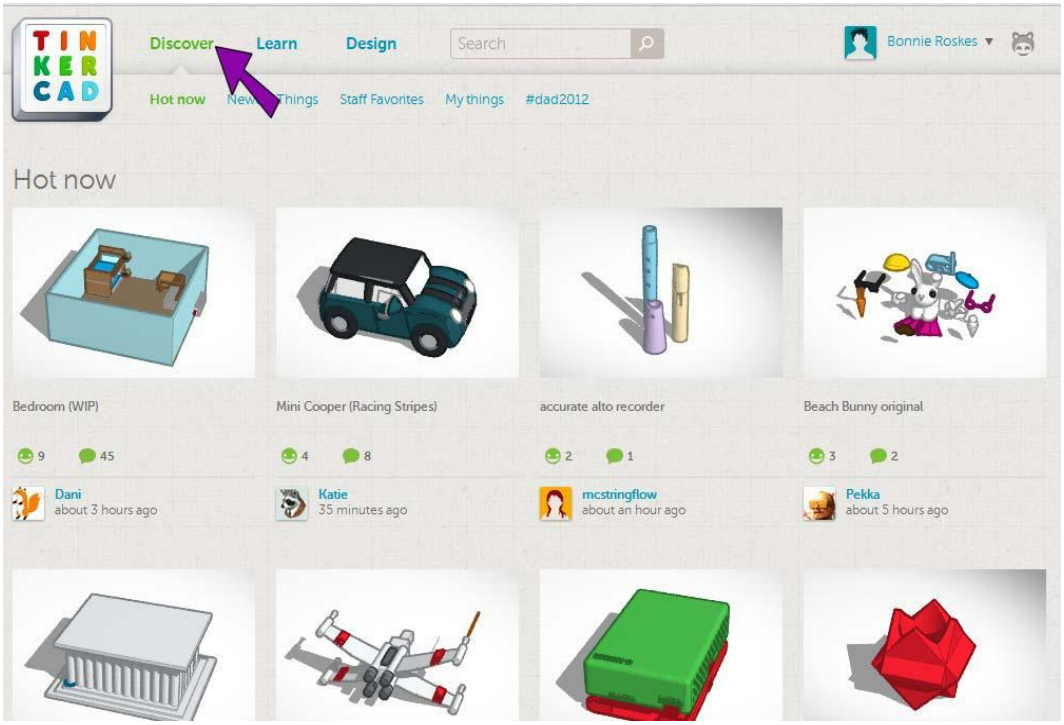


At the top of the Tinkercad site are three main links: **Discover**, **Learn**, and **Design**.

2. Click the **Discover** link, which takes you to a page of interesting models you can peruse. At the top of this page you can also search for something specific, check out the newest models, see what models the Tinkercad staff loves, and sometimes you can even see special seasonal models (such as stuff for Father's Day).

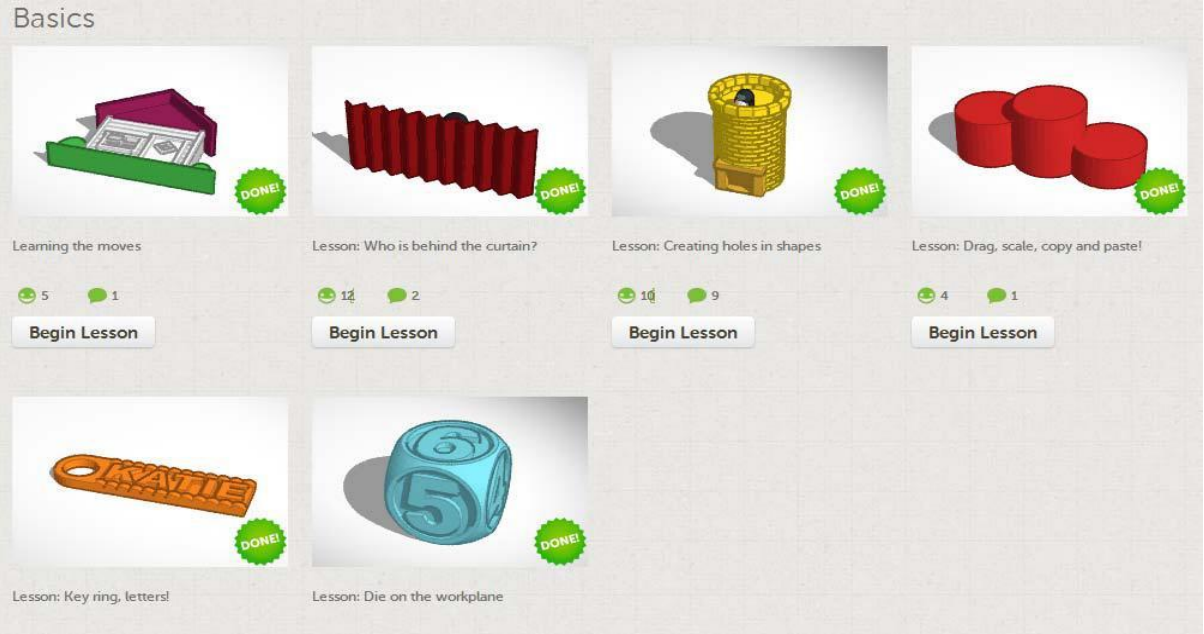
   If a model you see strikes your fancy and you want to see more, click on it to see a larger view. You can see a still view of the model, or view it in 3D so that you can turn it around and zoom in and out. The **Copy and Tinker** button lets you open it in Tinkercad so you can see how it was made; you can make any changes you like. And of course, you can send any Tinkercad model to a 3D printed, even if you didn't make it yourself!

   Your browser's Back button will take you back to Tinkercad's main pages when you're finished tinkering.



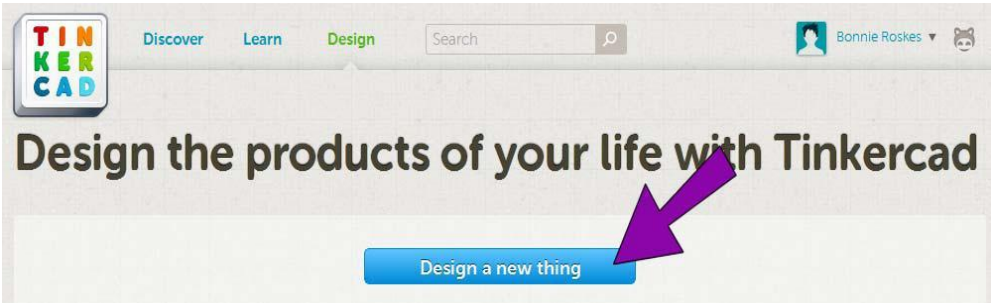
The **Learn** link at the top of the main page takes you to a series of lessons.

These are fun and short guided projects in which you follow directions in Tinkercad to create, move, and modify shapes. Try a few out.

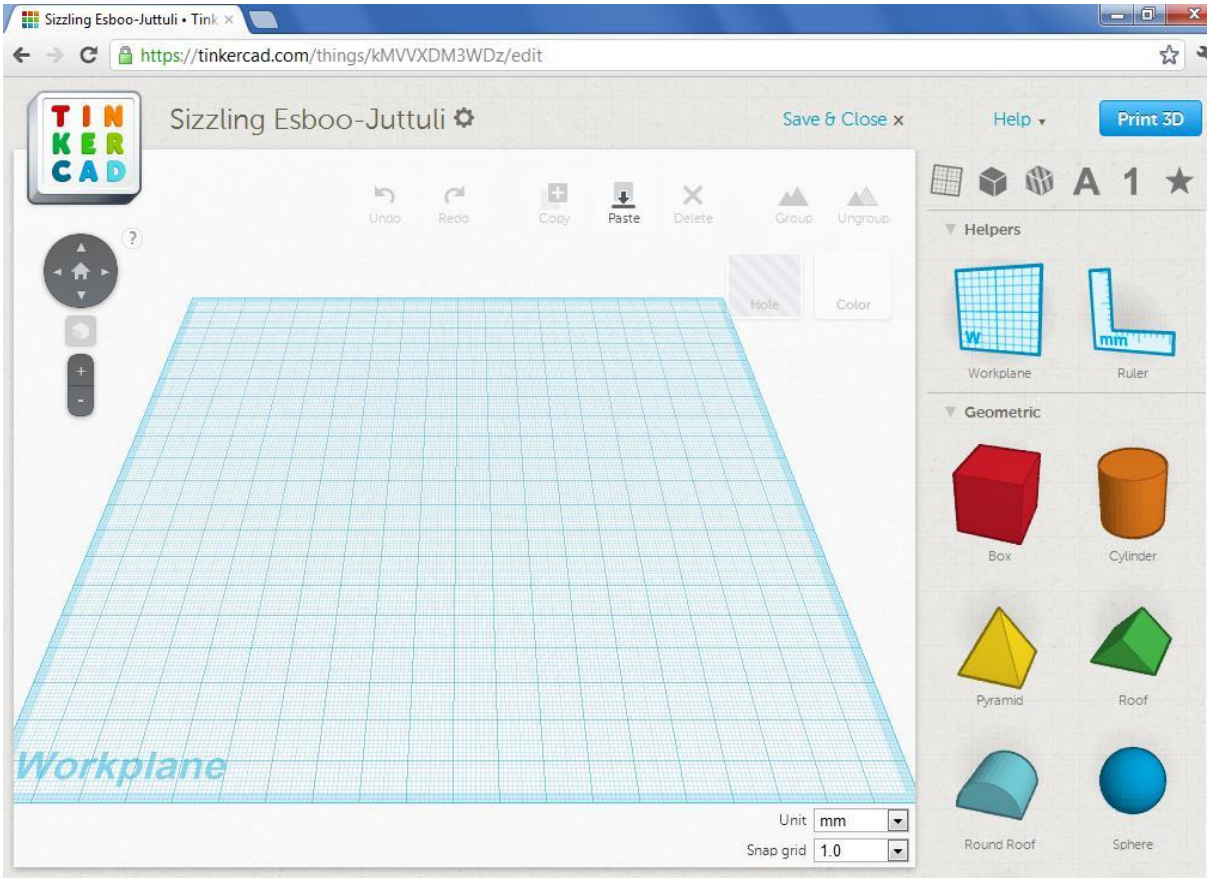


Start Your Thing - the First Shape

1. Ready to get started already? Click the **Design** link at the top, then click **Design a new thing**.



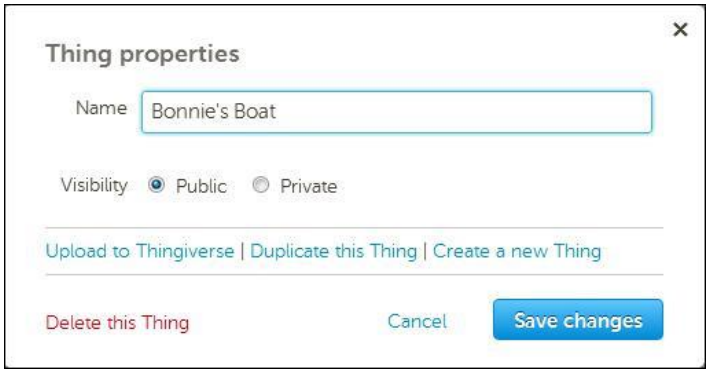
You're taken to a new webpage set up for your model, and your model is assigned a crazy name (what on earth is "Sizzling Esboo-Juttuli"?) An empty workplane (the large, blue grid) takes up most of the screen. The grid lines are all 1 mm apart, which makes it easy to see how large things are. **Snap grid** is set to 1 mm, which means you can move things by 1 mm increments (but you can change this via the **Unit** box at the lower right corner). The design tools are on the right side: the row of icons across the top open the various sets of tools: **Helpers**, **Geometric**, **Symbols**, etc. Scroll down the tool lists to see what's there for you to



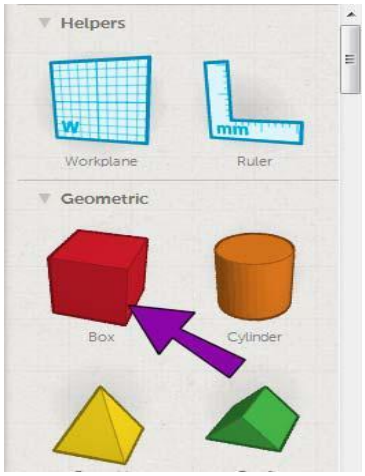
use.

2. Unless you love the strange model name you get, click the gear icon next to the name, which opens the **Thing Properties**.

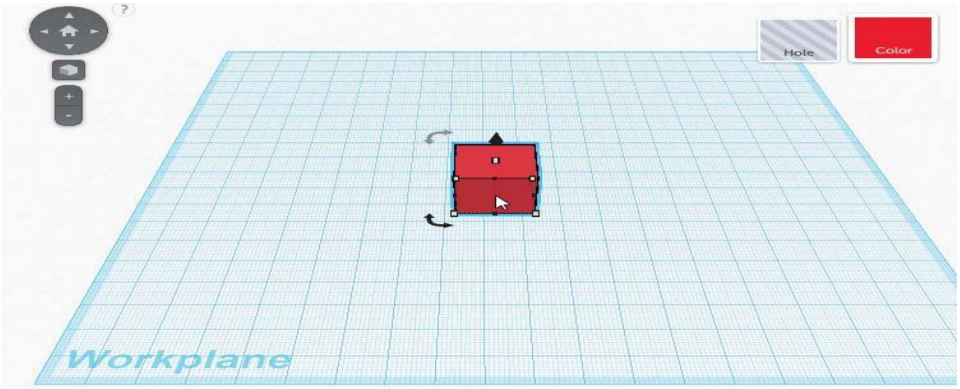
3. Set a new name, and choose whether it will be displayed for all to see (public) or just for you (private). Then click **Save changes**.



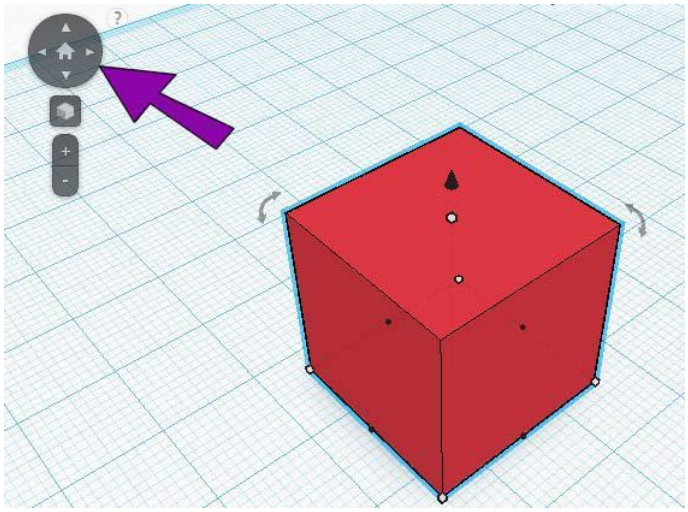
4. Let's start with the bottom of the boat. Click the **Box** tool, which is the first icon in the **Geometric** tool group.



5. Click anywhere on the blue workplane to add the box to the model.



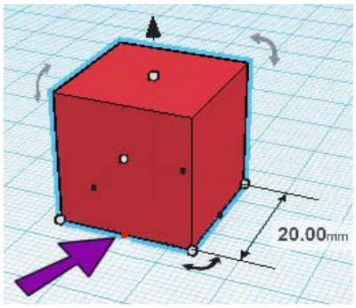
6. Before going on to make changes to this box, it's important to know how to "get around" in Tinkercad. The navigation tools in the top left corner are used to change your viewing angle: use the four arrows around the house icon to spin the model left or right, or to tilt the model up or down. You can also use the plus and minus icons to zoom in and out.



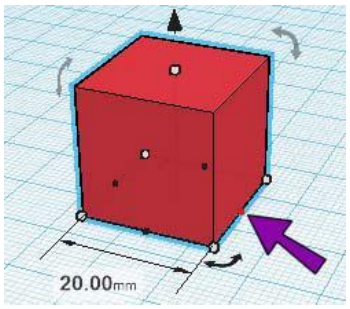
If you have a scroll wheel mouse, though, you don't need to use these navigation controls - you can rely on your mouse buttons, which is much more convenient. Press and hold the right mouse button and drag the mouse around - this is for spinning and tilting the model. Doing the same (holding the right mouse button) with the Shift key pressed lets you move the model. (Pressing and holding the scroll wheel does the same thing.) And finally, scrolling the mouse wheel up and down lets you zoom. Try out these moves with your mouse - once you get used to using these buttons, you'll never need to click those navigation buttons! (And if you forget which mouse buttons do what task, click the small question mark icon next to the navigation tools, for a reminder pop-up.)

The red box is outlined in light blue, which means it's selected, and it has all sorts of little squares and arrows all around it. To see what all these squares and arrows do, we'll hover our mouse over them ("hover" means to move the mouse somewhere, without clicking).

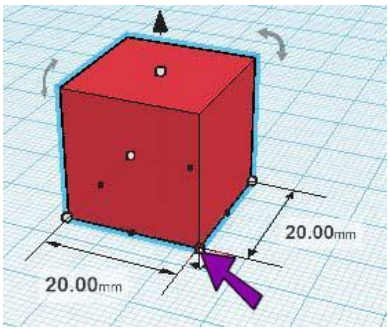
7. First, hover your mouse on one of the small black squares in the middle of an edge on the "ground" (also known as the workplane). The 20.00 dimension appears, showing you how long the box is in that direction - 20 mm.



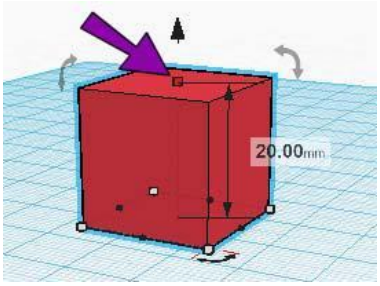
8. Hover over the same black square on another edge, and you'll see the same 20 mm measurement in the other direction.



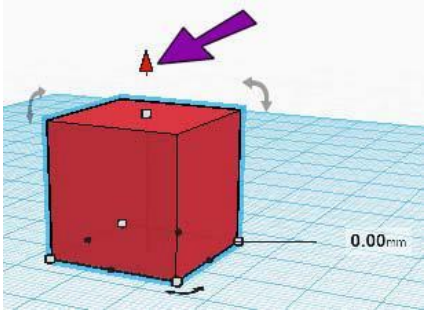
9. Hover over one of the white boxes on the corner, and you'll see both dimensions listed: 20 by 20



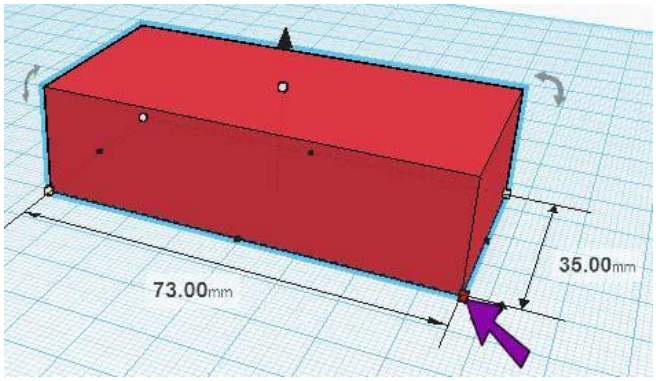
10. Hover on the white square at the top center of the box - it's 20 mm tall.



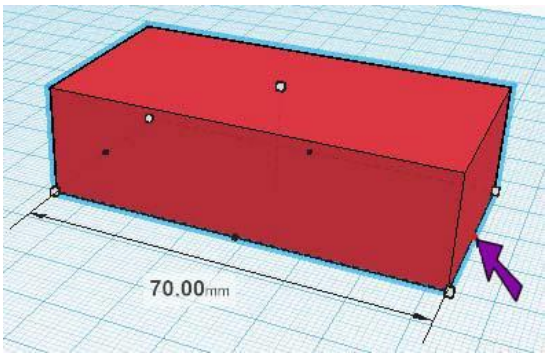
11. Hover over the round black arrow pointing up, above the top of the box. This measurement is zero, which means the box is sitting right on the workplane. (Say the box was "floating" 2 mm above the workplane - you'd see 2.00 instead of zero.)



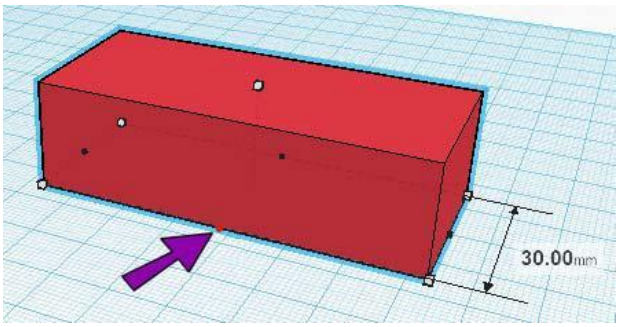
12. To make the box larger (but not taller), drag one of the white corner squares. Dragging a corner square lets you change both the length and width of the box. (It doesn't matter what size you make the box since we'll give the box exact sizes in the next steps.) Because the snap grid is set to 1 mm, you move in distances of 1 mm all the time (no fractions).



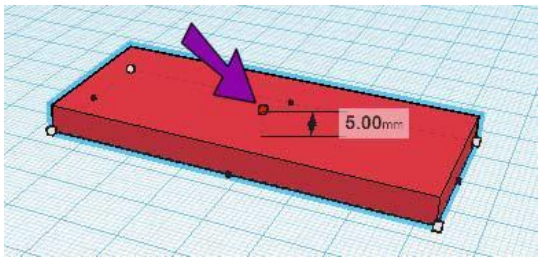
13. To set the box's length, click and drag the black square shown below, which resizes the box only in that specific direction. Stop when the box is 70 mm long.



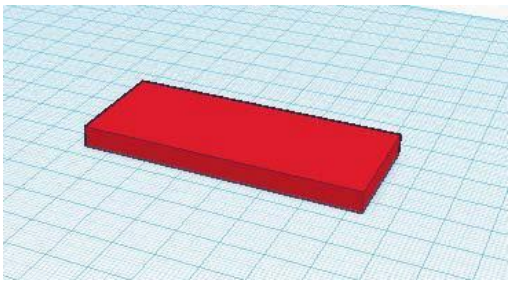
14. For the other measurement, use the arrow shown below, and stop when the width is 30 mm.



15. Next, use the white box on the top of the box to push the height down to 5 mm.



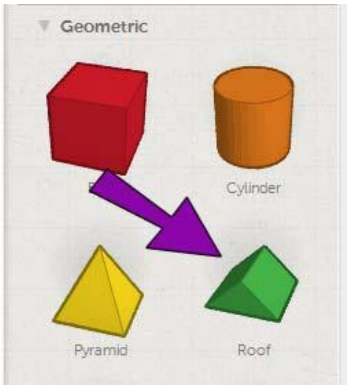
16. That's it for now with this box. To unselect it, click anywhere away from it.



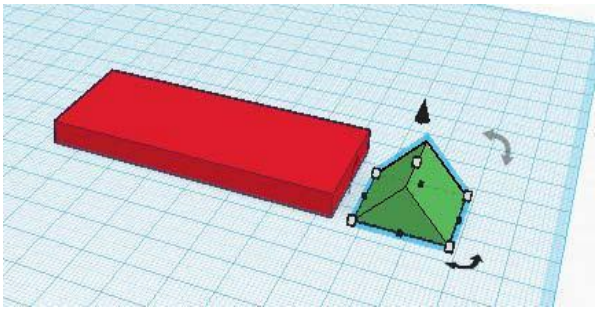
Chapter 3- Add a New Shape

The next part of the boat's base will be the sharp corner in front, which will help cut through the sea while this boat is speeding along. The trick with Tinkercad is to find a shape that resembles what you need, even if it takes a little tinkering to make the shape work.

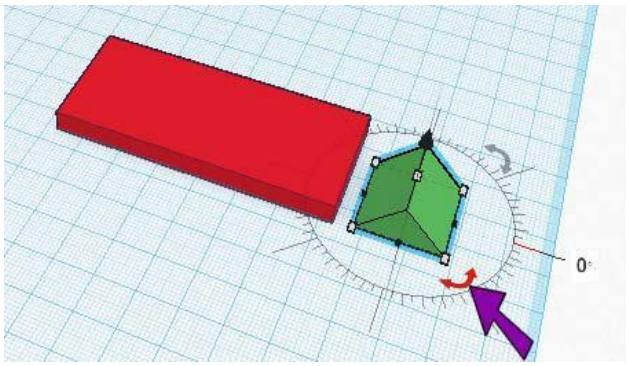
1. From the Geometric tools, click **Roof**.



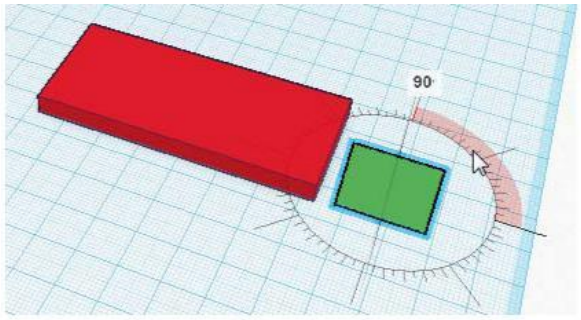
2. Click to place the roof in front of the narrow part of the box.



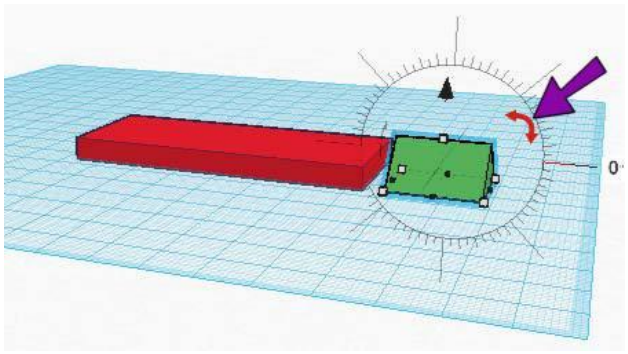
3. This shape isn't facing the right way, plus it's not exactly the right size. We'll tackle these problems one at a time. First, the shape needs to be rotated. Hover your cursor on the curvy arrow shown below, and you'll see a gray circle with degree markings appear. So now you know - these curvy arrows are used for rotation.



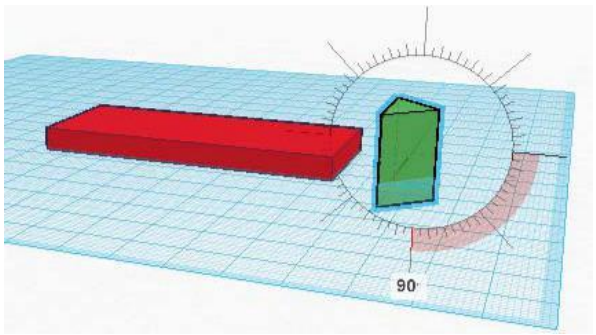
4. Click this arrow and drag your mouse around the circle, until the roof shape has rotated 90 degrees.



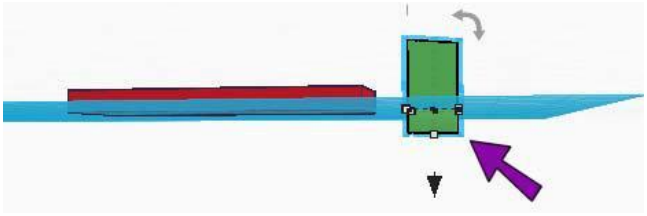
5. The roof shape still isn't facing the right way; it needs to be rotated one more time. Turn the model so that the model looks like the picture below, and this time hover over the curvy arrow indicated below. The gray circle you see is now vertical, which is the way we want to rotate the roof shape.



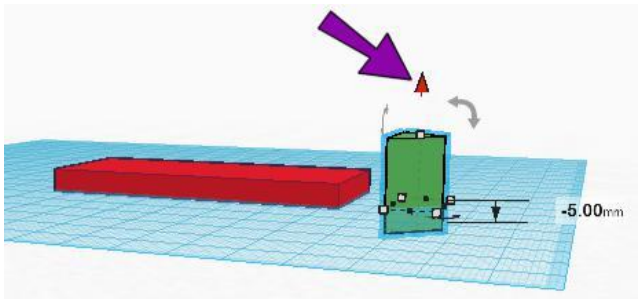
6. Click and drag this arrow downward, again stopping when the angle is 90 degrees. Now the roof shape is facing the right way, with the flat side facing the box, and the sharp corner facing the other way. But the shape is entirely the wrong size.



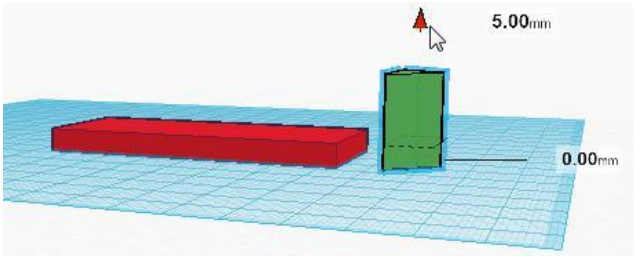
7. The first problem to fix is that the shape is now sitting below the workplane. Turn the model so that you're looking straight on at the workplane, and you'll see the bottom of the roof shape sticking out below the workplane.



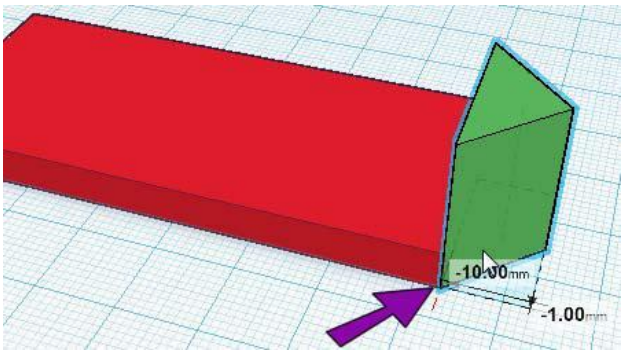
8. The round, black arrow pointing up above the top of the roof shape will let us fix this problem. Hover over this arrow, and you'll see that the bottom of the roof shape is - 5 mm below the workplane, which is why the distance has a negative value (-5.00 mm).



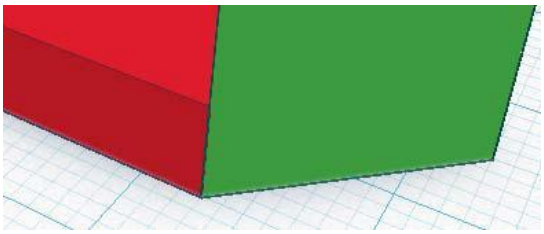
9. Drag this arrow up 5 mm, so that the distance above the workplane becomes zero.



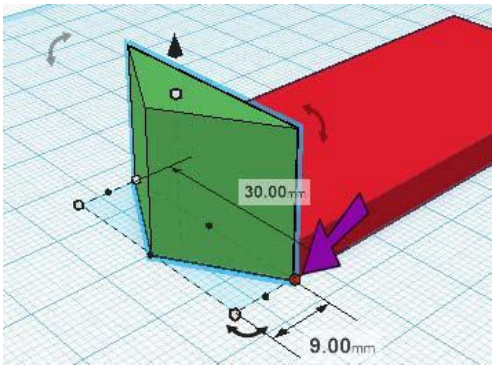
10. Now drag the corner closest to the red box to meet the box itself.



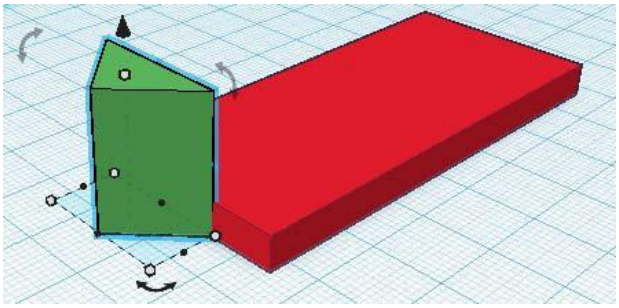
11. When connecting objects, it's always a good idea to zoom in closely to make sure they're connected, and there are no gaps.



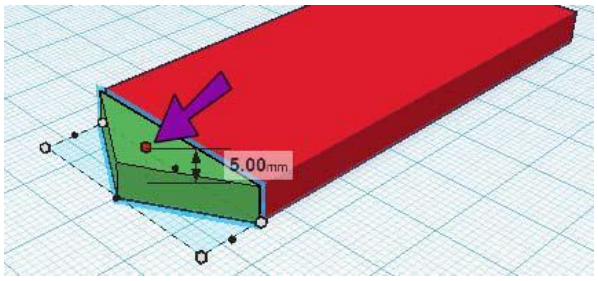
12. Spin your view around to see the other side of the model - this corner now needs to be fixed



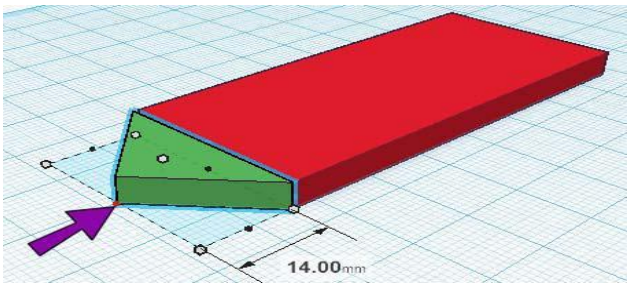
13. Drag this corner to meet the correct corner of the box. (And be sure to zoom in to be sure the two objects meet exactly.)



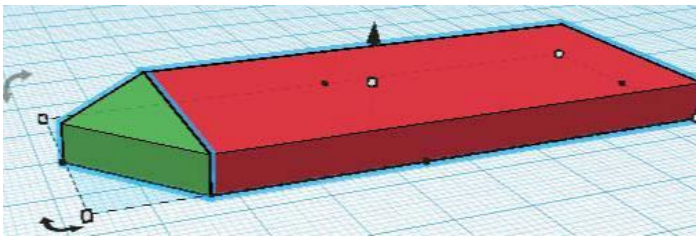
14. Use the white square on top of the green roof shape to push it down to be 5 mm tall, the same height as the box.



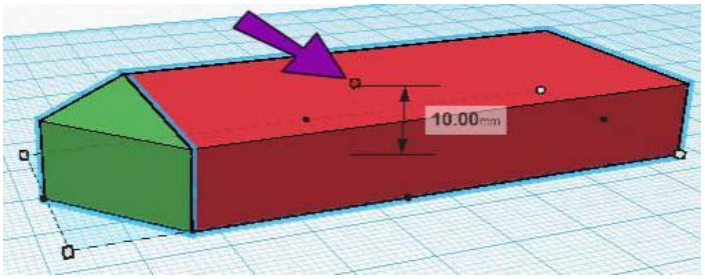
15. To make the sharp corner a little sharper, use the black arrow shown below to pull the corner a little farther from the box so that the green shape is 14 mm long.



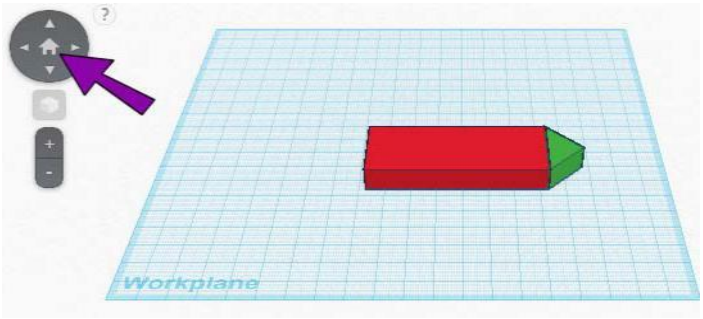
16. Say we want the entire base of the boat to be taller. You could pull up the box first, and then the roof shape. But you can also pull them both up together. The roof shape is already selected, and you can select the box shape as well. Just press and hold the Shift key and click the box. Now both shapes are selected.



17. Use the white square on the top of the two shapes, to pull the whole thing up to be 10 mm.



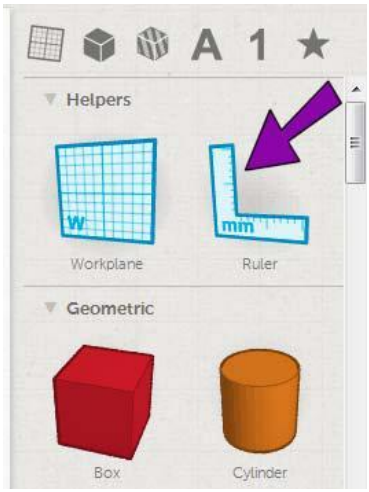
18. To get back to the default view, click the house icon at the center of the navigation tools.



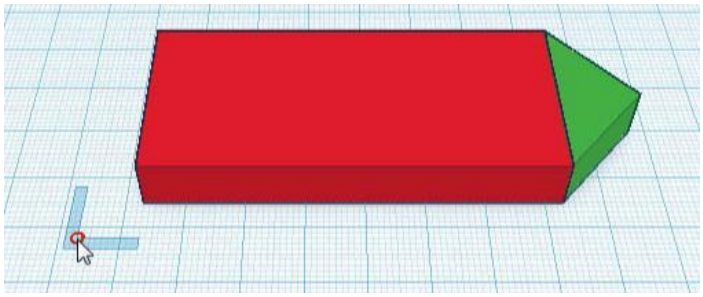
Chapter 4- Build the Boat Cabin

The cabin of the boat will sit on top of the base, just above the red box. It will be smaller than the red box: 4 mm in from the edges of the base.

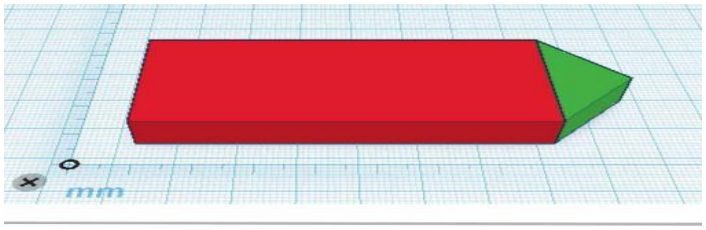
1. You probably remember that the red box is 70 mm long and 30 mm wide. But what if you forgot? Click the **Ruler** tool, located in the top row of tools, to help you remember.



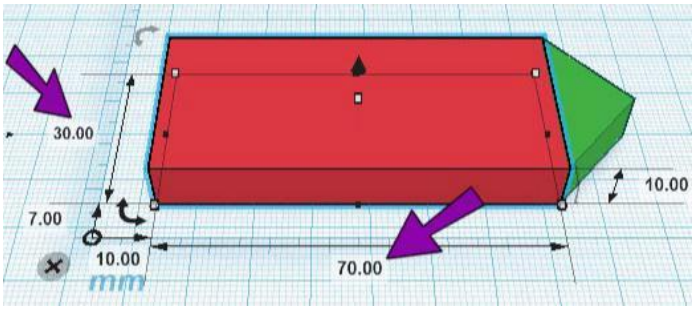
2. Click anywhere on the workplane to place the ruler.



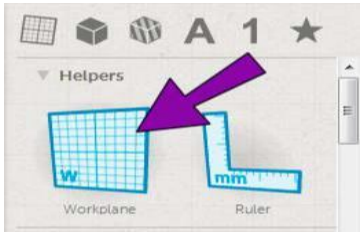
3. After you click, the ruler appears in two directions, horizontal and vertical, set to measure in millimeters.



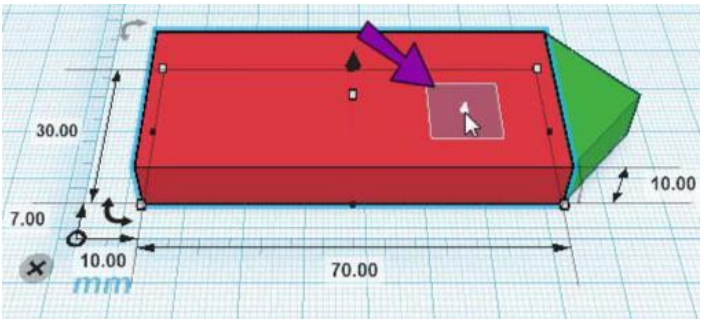
4. Now click the red box. The important measurements are the 70 and 30 - now you officially "remember" the size of this box. The rest of the measurements, which we don't need right now, tell you the box's height (10 mm), and how far the box is from the spot where you clicked to place the ruler.



5. The cabin is to go on top of the boat base, and all objects in Tinkercad are placed on the workplane. So, we need to move the workplane to the top of the base. Click the workplane tool.

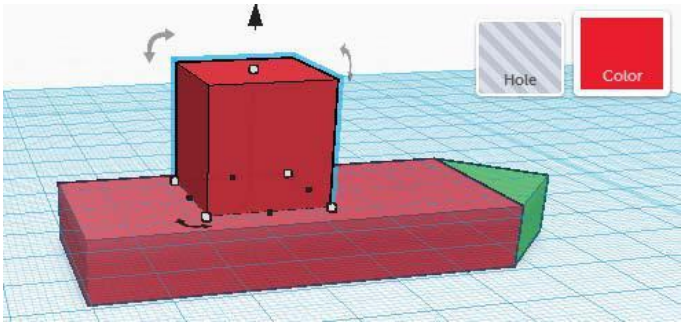


6. Move your mouse to the top of the red box, and you'll see a gray square appear, showing you where the workplane will go.

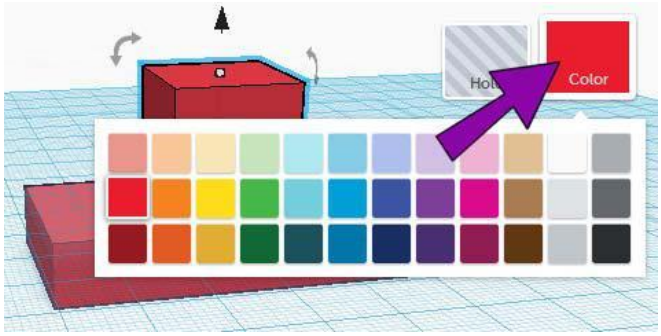


7. Click to place the workplane there. The ruler disappears since its workplane is now gone. And if you tilt the model up to the view shown below, you'll see that the workplane is now on top of the boat base.

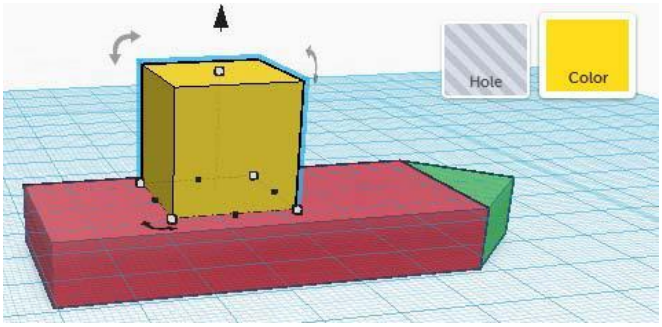
8. Click the **Box** tool and place the new box on the workplane.



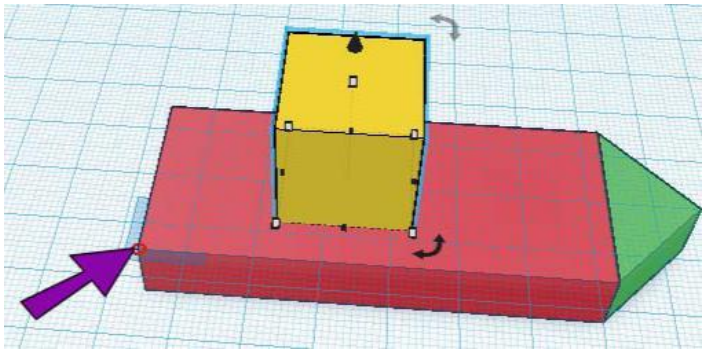
9. Why have two red boxes? While the new box is still selected, click the **Color** box . . .



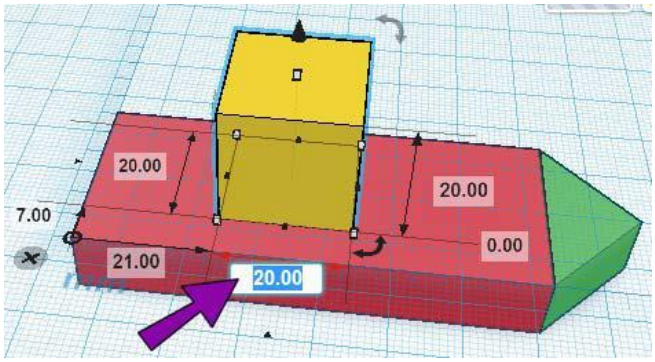
10. And choose the yellow color.



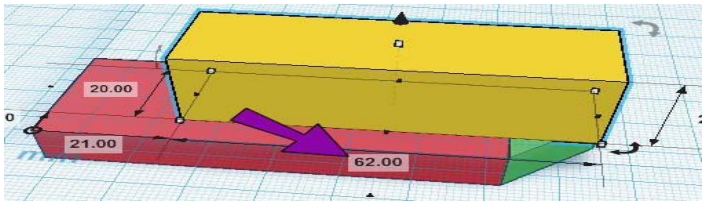
11. There are many ways to size this yellow box so that its edges are all 4 mm inside the edges of the red box. The way I'll show here uses the help of the Ruler. Click the **Ruler** tool and place it right at the corner of the red box.



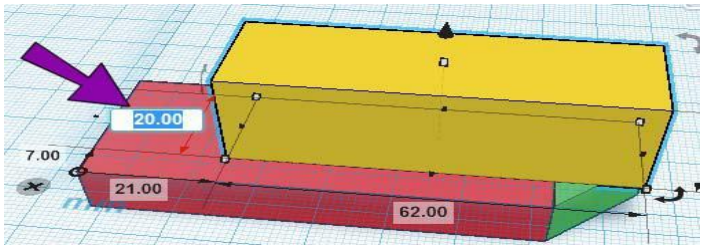
12. Click the 20-mm measurement that defines how long the box is. After you click the number, it can be changed by entering a new number.



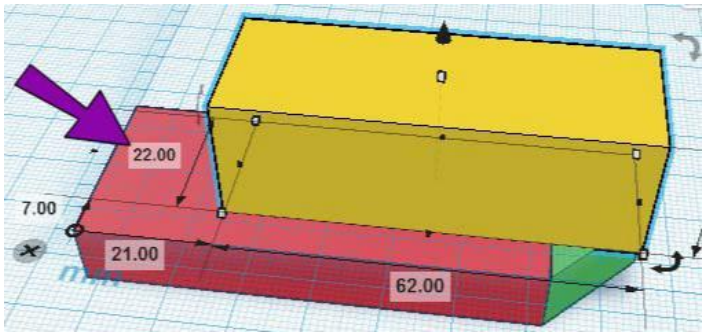
13. How long should this box be? The red box is 70 mm long, and the yellow one needs to be 4 mm shorter on both sides. So, 70 - 4 - 4 = 62 mm. Type 62 and press Enter, and the box becomes the correct length.



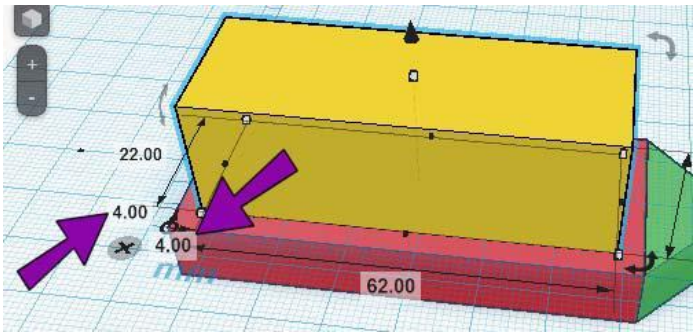
14. Now the width needs to be changed. Click this 20-mm measurement . . .



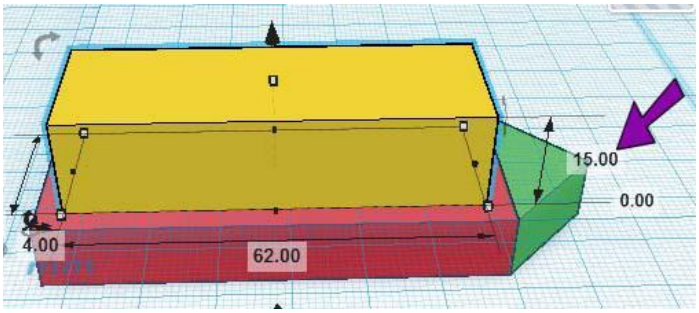
15. and change it to 22 mm (30 - 4 - 4 = 22).



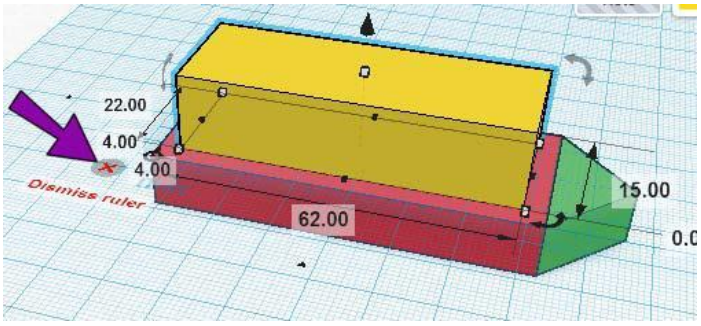
16. To move everything into the right place, change both two measurements shown below to 4 mm.



17. The cabin looks a little tall at 20 mm, so change the height dimension to 15 mm.

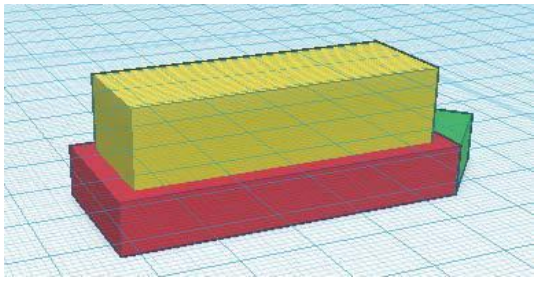


18. That's it for changing measurements, so click the X of the ruler, to make it disappear.

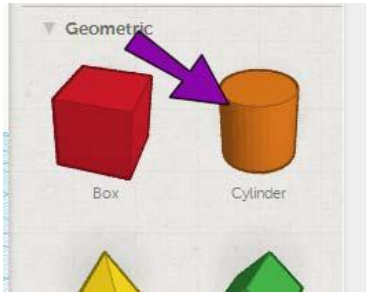


Chapter 5- Add Smokestacks

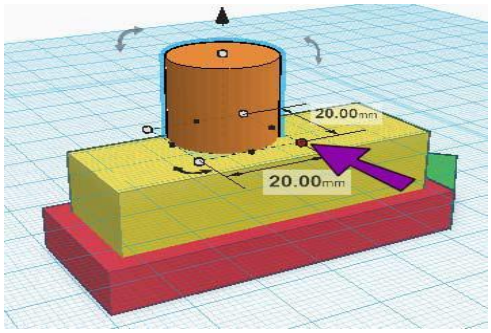
1. In order to place three smokestacks atop the cabin, place the workplane there.



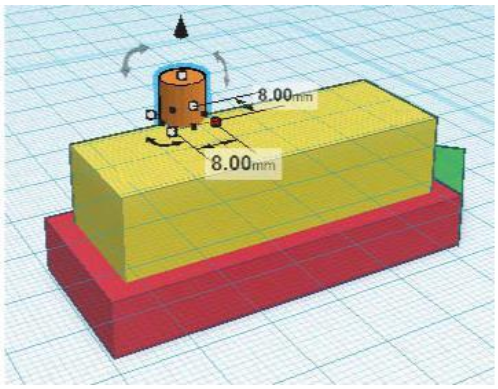
2. Click the cylinder tool.



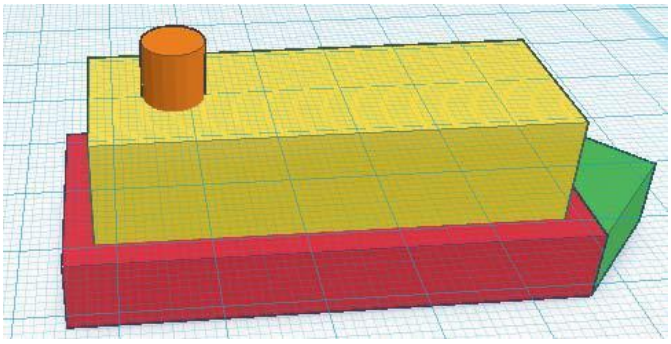
3. And place it on the workplane, on top of the cabin.



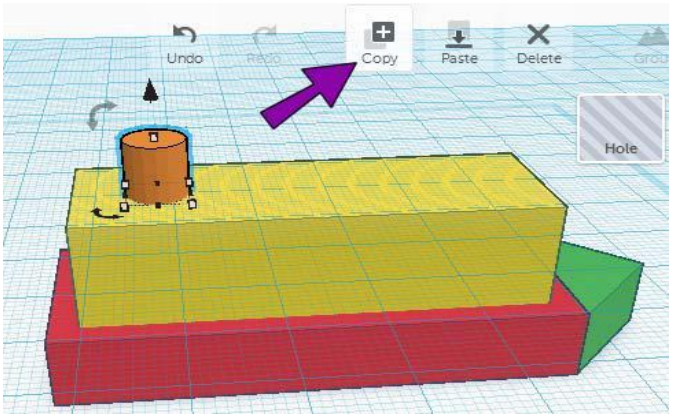
4. We've seen a few ways to change the size of an object. Here's another neat feature of Tinkercad: drag one of the black or white boxes along the bottom, keeping the Shift key pressed. This keeps the overall cylinder shape the same. Stop when the diameter is 8 mm.



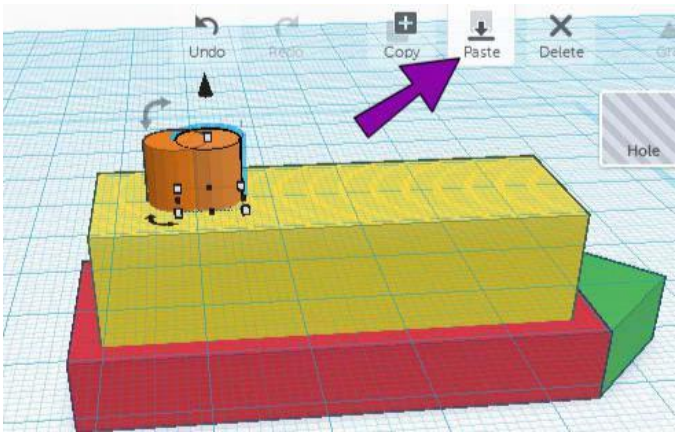
5. Move the smokestack (drag it or use the arrow keys) so that it's centered near the back of the boat. (If you want to be exact, there should be 7 grid squares of the cabin to the right, left, and back of the smokestack.)



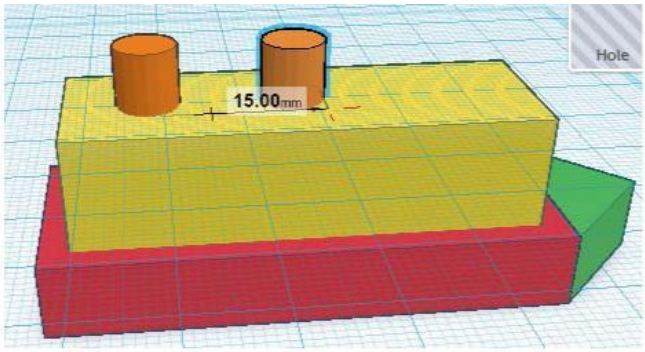
6. We need more than one smokestack on this boat. So, click the smokestack, then click the **Copy** icon. (Or you can press the CTRL+C keys together.)



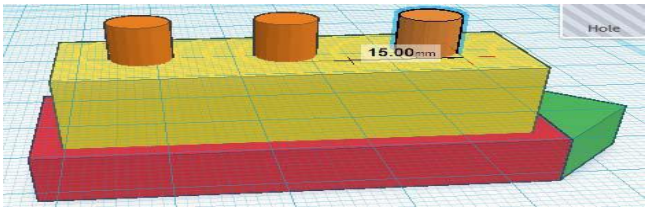
7. Then click the **Paste** icon or press CTRL+V. This places a copy directly to the right, so where the copy goes depends on how you're looking at the model. And the distance between the two smokestacks is half the length of the smokestack cylinder. (The smokestack has an 8-mm diameter, so the copy distance is 4 mm.)



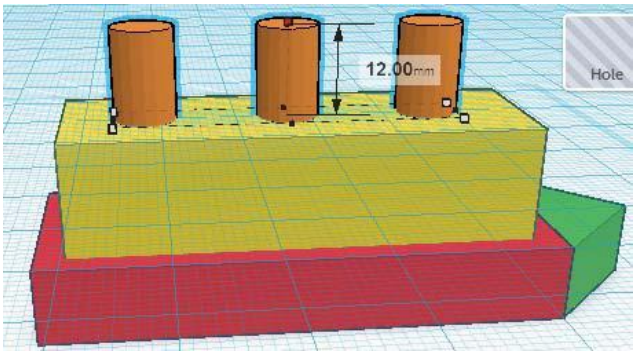
8. To move the new smokestack farther away from the first one, click anywhere on the new smokestack *except* on a black or white square. Drag it toward the front of the boat, keeping the Shift pressed so the move will stay straight. I've moved mine 15 mm to the right so that the two cylinders are now 19 mm apart (15 + 4) between their centers.



9. For a third smokestack, click **Copy** and **Paste** again . . . and move this copy using the same distance you used before.



10. The smokestacks look a little puny, so select them all (remember to press Shift to select more than one object at a time), and use the white square at the top to pull them all up to 12 mm.

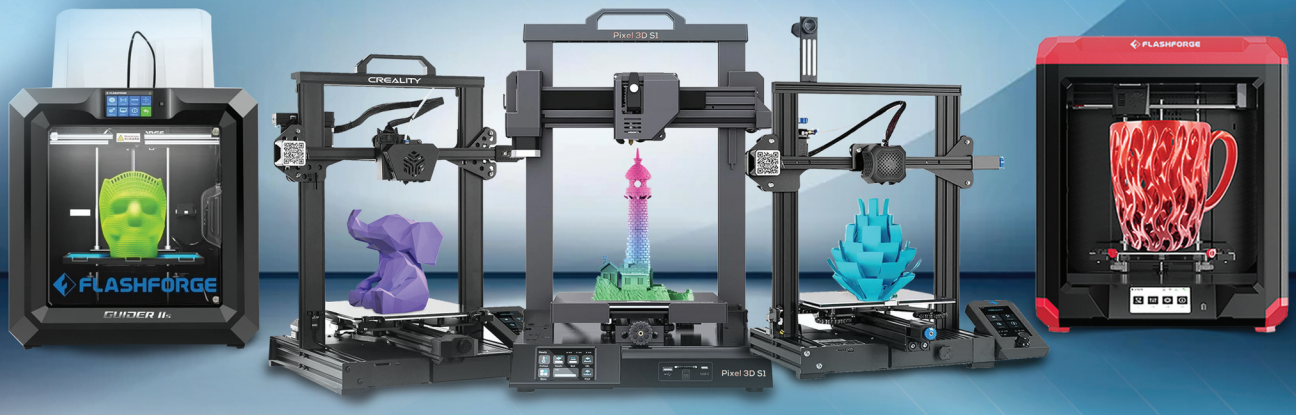


At the top of the web page, click the **Save & Close** link.

Your program is ready to transfer to 3-D printer for printing.


UNIVERSAL ROBOTS


TOWER PRO


FLASHFORGE
CREALITY
Pixel 3D S1
Pixel 3D S1
FLASHFORGE