

Getting Started with 3D Printing

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Note: The most recent version of this document is available at <http://RomichFoundation.org/3DPLL>. The version that is on the flash drive provided may or may not be current. With an Internet connection, reading this document on the computer will make it easier to follow the links. Internet connection is covered in “The Computer” section of this document, Page 12. You may want to skip there now and then come back. (Plug the computer power adapter in, so the computer will not stop when the battery gets low.)

From Wikipedia (https://en.wikipedia.org/wiki/3D_printing):

3D printing, or **additive manufacturing**, is the construction of a three dimensional object from a **CAD (Computer-Aided Design)** model or a digital **3D model**.^[1] The term "3D printing" can refer to a variety of processes in which material is deposited, joined or solidified under **computer control** to create a **three-dimensional** object,^[2] with material being added together (such as plastics, liquids or powder grains being fused together), typically layer by layer.

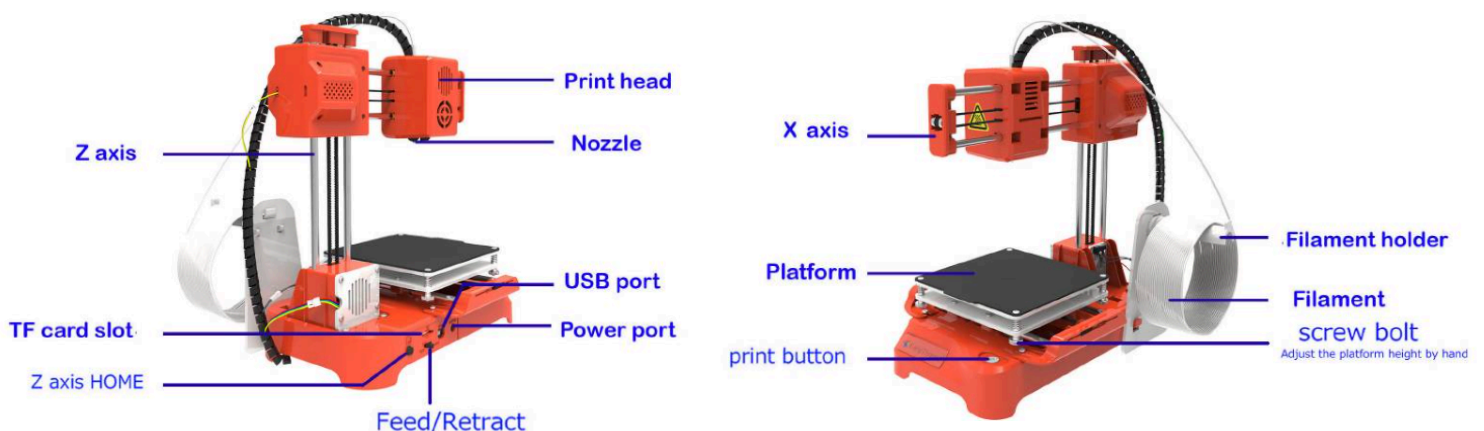


Table of Contents

Background	3
Safety	4
• Heated Nozzle	
• Emissions	
• Fire Safety	
The Kit Includes	5
Printing an Object – Step by Step	
• Bed Leveling	6
• Load Filament	8
• Start Printing	9
• Remove the Printed Object	9
Learning More about 3D Printing	
• 3D Printer	10
• 3D Filament	10
• The Memory Card	11
The Computer	12
3D Printed Files	14
Slicing Software	15
• Printer Settings Setup	17
• Material Settings	18
• Uploading & Exporting Files	19
Other Resources	21
Next Step?	21

Background

In recent years, 3D printing has become accessible to students, hobbyists, and makers. The knowledge and skills to create 3D printed objects can be useful in many ways, including preparing one for academic success, employment opportunities, entrepreneurship, and more. The cost of 3D printing has been falling, but is still high enough that it may be out of reach to many.

This 3D printer kit was made available through a lending library program that was inspired by the availability of low cost hardware, initial availability of Windows computers, and the notion that people may want to have a trial 3D printer experience before making their own investment. The original Windows touchscreen computers were donated by PRC-Salttillo (<https://www.prc-salttillo.com/>) in Wooster.

The essence of this program is that a package containing everything needed to initially explore 3D printing can be borrowed for a period of time. This includes a 3D printer, a Chromebook computer and some filament. This is being made possible through the donation of mice from PRC-Salttillo (<https://www.prc-salttillo.com/>) in Wooster and the donation of 3D printers, PLA filament and other items from Romich Foundation (<http://romichfoundation.org/>) in Creston. The initial 3D printer being used in this program is the EasyThreeD Model K7. This 3D printer uses PLA filament and has a working volume of about a 4" cube. Other 3D printers may be used.

New 3D printer users must read

If you are the first time to use 3D printer, you may don't know how to start. First of all, we need to know that 3D printer can only print gcode format 3D model files. General 3D model files are STL format, STL format files need to be sliced by slicing software and converted into gcode format model files, then you can print. The following is a brief introduction to several basic methods for printing models using 3D printer.

The 1st method: children level

This is the simplest operation. Download the gcode format 3D model from the website, copy it to the TF card, insert the TF card into the 3D printer, and print it.

download gcode file to TF card

 →

Insert TF card and print

The 2nd method: entry level

Download the STL format model file from the website, then slice it into gcode format file with Easyware slicing software, copy it to TF card, insert the TF card into 3D printer, and then print (easyware slicing software is beginner slicing software, the printing effect not very good).

download STL file to computer

 →

Easyware slicer slice to gcode

 →

Insert TF card and print

The 3rd method: intermediate level

Download the STL format model file from the website, then slice it into gcode format file with Cura slicing software, copy it to TF card, insert TF card into 3D printer for printing, and then print. (Cura slicing software is a professional slicing software, the printing effect is good).

download STL file to computer

 →

CURA slicer slice to gcode

 →

Insert TF card and print

The 4th method: advanced level

Use E3dmagic modeling software to create STL format 3D model, then slice the STL file to gcode format by Easyware or Cura slicing software, and then copy gcode file into TF card, insert the TF card into 3D printer, and start to print. (E3dmagic is a very simple modeling software independently developed by EasyThreeD).

E3dmagic make 3D model

 →

Easyware or CURA slicer slice to gcode

 →

Insert TF card and print

Notice: if there is no paper manual attached to the machine package, please read the manual inside the TF card, Please watch operation video in Youtube channel EasythreeD 3D, also can watch the video or download manual at website: www.easythreeD.com
Teach beginners to learn 3D printing: www.toy123d.com

Safety

While there are some moving parts on 3D printers, they are generally not of a nature to be considered a hazard. However, there are three other potential safety issues.

Heated Nozzle

The nozzle from which the plastic is extruded to make the piece being printed is **HOT!** This is necessary for its basic function of liquefying the filament so that it can be squirted out at the right place at the right time. **DO NOT TOUCH THE NOZZLE** when it is **HOT!**

Emissions

The second safety concern is emissions. When they are operating, filament-based 3D printers emit both particulate matter (PM) and volatile organic compounds (VOCs), both of which have health concerns. The 3D printer and filament used in this kit have features that keep this exposure to a minimum. This includes the nozzle size of 0.4 mm and the use of PLA material filament.

You can learn more, including things to do and not do relative to emissions, at:

<https://all3dp.com/1/3d-printing-emissions-air-quality/>.

Romich Foundation has procured a Canaree I5 Air Quality Monitor for the purpose of measuring PM and VOC emissions from the 3D printer(s) used in this program and the effectiveness of any mitigation systems.

Fire Safety

As with most devices that involve elevated temperatures, the potential for fire exists. While there is no awareness of the history of fire with the 3D printers used in this program, it is prudent to be aware of the possibility. Ways to address this would be to not let the device run unattended. Another would be to have it located in a place where any such event would be contained and not spread to other combustible materials. For more information, read:

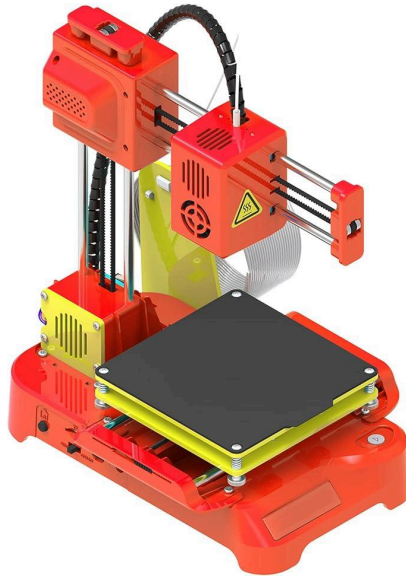
<https://all3dp.com/2/remote-home-3d-printing-safety-fires-and-failures/>

The kit includes:

- a. 3D printer (with memory card in the control box slot)
- b. Protective Computer Bag
 - I. Computer
 - II. Power Supply
- c. USB Expander with these items connected
 - i. Mouse
 - ii. Memory card adapter
- d. Two filament spools
- e. Filament spool stand
- f. **Getting Started with 3D Printing** manual
- g. Empty zipper bag for scrap
- h. Flash Drive

Printing an Object – Step By Step

So let's get started and print something. This section of this document is written for the EasyThreeD Model K7 3D printer.



When originally purchased (Walmart.com; Amazon.com; etc.), the Easy3D Model K7 requires a small amount of assembly and there is the need to put the contents of the memory card on your computer and put the first test file to be printed on the memory card. Those steps have been taken for you, the memory card is in the side of the machine with a file ready to print, and the 3D printer should be ready for the first print.

The first print activity does not require use of the computer. A file is ready to print and resides on the memory card that is already on the side of the machine. However, since the kit has been in transit, it would be good practice to check the bed levelness before the first print. This should not need to be done routinely, but might be checked periodically, especially if there seems to be an issue with the print getting started.

Bed Leveling (Not needed routinely)

Before using the 3D printer for the first time, the bed should be checked/adjusted so that it is level. The bed is the horizontal platform on which the object will be printed. For the printers used in this lending library, the bed moves in X (left and right) and Z (up and down) directions. The initial space between the nozzle and the bed should be set to optimize the way the first layer of the object is printed. Once set, unless there is some reason why the bed would have moved, this step should not need to be repeated. However, it may be prudent to check it periodically.

The first step in this process would be to check the bed level. Plug the 3D printer power adapter into a receptacle and connect the power adapter to the control box. (The PLAY button light should be on.)

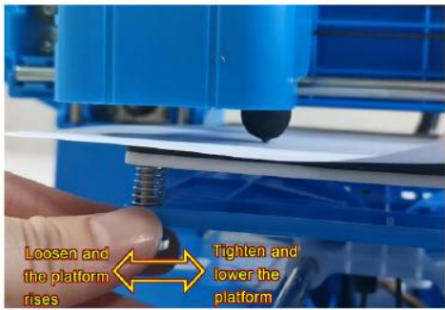
Firstly put a piece of paper on the platform, the paper a little larger than the printing platform. Press the leveling button 1, and the print head will automatically move to the the platform. It should stop moving with a small distance between the nozzle and the bed plate. The 1, 2, 3 and 4 on the leveling button will match the Platform.



Adjust the screw nut at the bottom of the platform (as shown in the figure below, loosen the nut, the platform rises, tighten the nut, and the platform falls). Adjust the height of the platform through the nut so that the gap between the nozzle and the platform is just one sheet of paper thickness (about 0.1mm).

When the paper is gently pulled, there is obvious friction between the paper and the nozzle, the nozzle will not damage the paper.

Note: When adjusting the nut, do not press the platform with your hand to avoid affecting the accuracy of leveling.



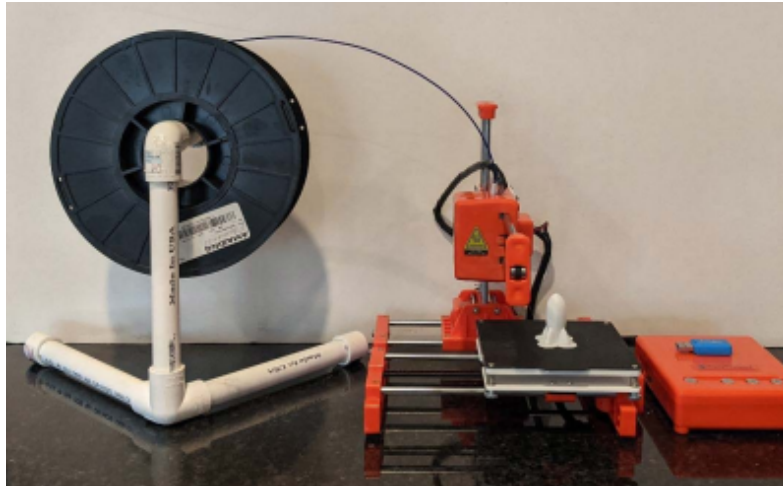
After the 1 point is adjusted, press the leveling button 2, and do the same steps above to complete the leveling of the 2 positions. After that, use the same method to continue to complete the leveling of 3 and 4 points.

If there are still print problems, you can repeat the whole leveling work 1-2 times.

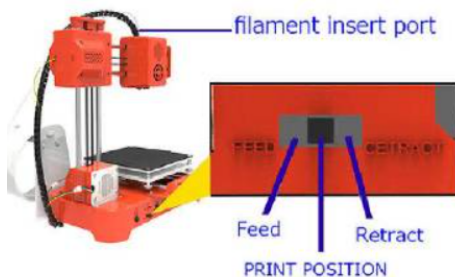
Load the Filament

First raise the print head. To do this, press the **PLAY** button for about three seconds and then release it. The print head should go up about 1 cm (~3/8"). Do this three or four times, so that the bottom of the nozzle can easily be observed.

Mount a spool of filament on the holder as shown in this photo. Filament with a diameter of 1.75 mm is fairly standard for small 3D printers.



Insert the filament into the insert tube until it cannot go farther, and press the filament with a little force to keep it. Then use another hand to move the switch (at the side of the printer control box base) to "**FEED**" gear (As shown in the figure below).



The light of the print button will start blinking. Blinking fast indicates that the nozzle is heating up. When the temperature reaches, the light turns to blinking slowly, and the motor gear starts to turn and roll the filament into the nozzle. **The whole process needs to be pressed by hand to ensure that the filament can be caught and rolled in by the gear.** When the filament comes out from the nozzle, it means that the feeding is successful. The whole feeding process takes about 1 minute. **(Remember that the nozzle is HOT!)**

Please be patient and wait. After the feed succeeds, you must shift the gear back to the middle PRINT POSITION

***Caution: The nozzle temperature will reach about 200 degrees Celsius. This is hot enough to cause a burn on skin. Do not touch the nozzle when it is hot. ***

Start Printing

To start printing, press and release the **PLAY** button. The **PLAY** button will begin to flash slowly. When operating temperature has been reached, the print head will move to the corner, then move down to the surface, then printing will begin.

The printer looks for the GCode file on the memory card that is the most recent. When the kit is sent out to a borrower, the **rocket.gcode** file is on the card and so the result of this first printing process should be the rocket. This should take roughly 30 minutes.



If something goes wrong and stopping the printer is needed, press and hold the **PLAY** button for three seconds and release. Also, if at any time the 3D printer seems to be confused or is not doing what you think it should, as with many other electronic devices, unplug the power cable, wait five or more seconds and reconnect it.

Remove the Printed Object

The object that has been printed is now adhered to the black base surface. That surface has a magnetic back and can be removed. Once removed, it can be flexed to separate the object. The object has a skirt a few layers thick that can be snapped off.

Note: When you are done printing, unplug the power cable until your next session.

If you plan to be moving the 3D printer before the next use, then it would be good to retract the filament from the print head. To do this, press and release the – button. The light will flash rapidly until the nozzle is hot enough to allow the filament to move. Then it will retract the filament from the print head. When it is free, pull the filament out of the white Teflon tube and press and release the – button again to stop the motor.

Learning More About 3D Printing

If you haven't done so already, this would be a good time to read the Wikipedia reference on 3D printing at the beginning of this document. Also, browse the resources, including videos, at these sites: "Teach beginners to learn 3D printing: www.toy123d.com" and www.EasyThreeD.com.

If you are more inclined to use audio/video learning, do a YouTube search on 3D Printing. Here is one, but there are many:

<https://www.youtube.com/watch?v=3LBTkLsjHGQ>

3D Printer

The 3D printers used with this lending library are based on **Fused Deposition Modeling (FDM)**. This means that they use a filament of a plastic type material that is heated to liquid form and squirted out a nozzle in a controlled manner, where it cools to a solid form. This is sort of like a hot melt glue gun under computer control.

There are other methods of 3D printing and they can be studied at the Wikipedia site.

Different 3D printers may be used as part of this program. All are relatively low cost, which means that they are also more basic, smaller, slower and have fewer features than more costly models. Part of the goal of this lending library program is to build familiarity and experience that can be helpful in making a future purchase decision.

3D Printer Filament

The 3D printers used with this program all use PLA filament material. Google offers this:

Polylactic Acid, commonly known as PLA, is one of the most popular materials used in desktop 3D printing. It is the **default filament** of choice for most extrusion-based 3D printers because it can be printed at a low temperature and does not require a heated bed.

PLA is produced from renewable resources, meaning that it is not based on petroleum products.

There are many different filament materials. Here is a resource to learn more:

<https://www.simplify3d.com/support/materials-guide/>

A table comparing various properties of a dozen filament materials is at:

<https://www.simplify3d.com/support/materials-guide/properties-table/>.

Scrap material can be returned with the kit for recycling. It is possible to grind the scrap into small pieces and then to extrude it into filament for reuse. A zipper bag is included for this.

The Memory Card

A USB adapter comes with this kit for connecting the memory card to the computer. The adapter can be left plugged into the USB expander, and the memory card can be moved back and forth between the computer and the 3D printer.

When removing the card from the computer, use the **Eject** function to reduce the chance of damage to the card or to the file.

To be safe, have the control box unpowered when inserting or removing the memory card.

The card has the capacity to hold much more information than the size of the GCode file to be printed. However, the printer will always print the most recent GCode file.

The Computer

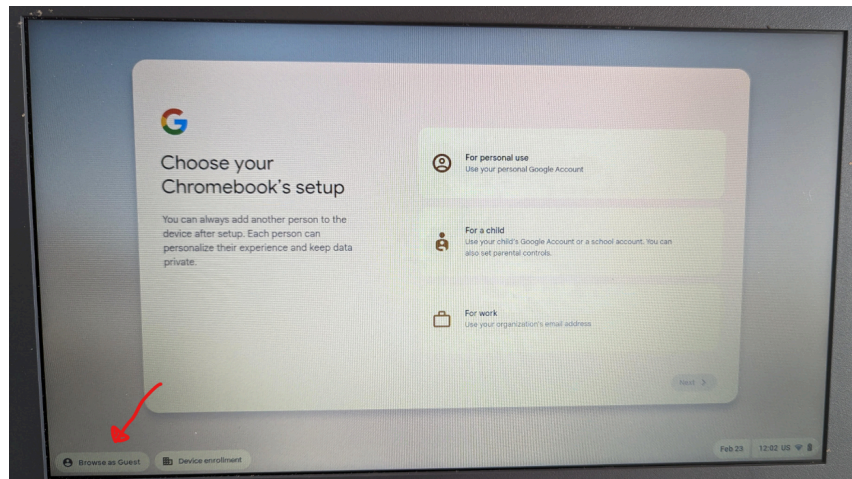
The computer provided with this kit is a Chromebook. It has two USB ports, so a USB port expander is included. This allows the mouse, flashdrive, and FT USB card reader to be connected at the same time. Experience suggests that best results are achieved when using a mouse, as opposed to trying to use the touchpad mouse. It is advised that the power adapter remain connected to the computer to avoid the possibility of losing any information should the computer power down with low battery.



The computer is provided in a zipper pouch for protection during transport. Connect the power supply to the computer and then to an AC power outlet.

Hold down the power button in the right upper corner to turn the computer on.

Upon powering up the computer you will be presented with the following screen:



In the bottom left hand corner select “Browse as Guest”

After this action you will be asked if you accept the terms and conditions. Select **“Accept and continue”**

You have successfully logged into the computer and are ready to get designing, downloading, and making projects.

The first task is to connect to the local wireless Internet network. To do this, click on the wireless icon on the right side of the taskbar in the bottom right part of the screen and follow the process of getting connected. To complete this step you will need to know your network name and password.



Everything from this point forward is web based meaning the applications do not require installation onto the device. You will be able to research ideas, find downloadable files, create your own designs, and use the slicing software all within the google web browser.

Before returning the kit, you may want to save any files that were/are stored on the provided flash drive for future reference.

3D Printable Files

There are different sources for 3D printable objects. The most common approach for beginners is to start with files that already exist. GCode files that were created for this model 3D printer can be downloaded, put on the memory card, and printed directly. One source is the **Model Library** at <https://www.toy123d.com/en/>. If you have trouble getting the **GCode** files to print, then try the **.stl** files after running them through the Cura slicer (see below).

When my granddaughter visited a couple years ago, she wanted to make a 3D printed butterfly shaped cookie cutter. So we went to www.thingiverse.com, typed into the SEARCH box “butterfly cookie cutter”, and were presented with around fifteen possibilities. She chose the one she wanted, we downloaded the **.stl** file, ran it through Cura (which allows changing the size), put the resulting GCode file on a card, put the card in the 3D printer, and in under an hour we had a butterfly shaped cookie cutter.

This site links to around two dozen Internet resources for finding free files.
<https://all3dp.com/1/free-stl-files-3d-printer-models-3d-print-files-stl-download/>

Another approach for getting 3D printable object files is to draw your own. Free and low cost software is available to support this. **Tinkercad** (<https://www.tinkercad.com/>) is free and commonly used. Tinkercad also has step by step tutorials on how to create your own designs. This program is extremely user friendly and highly recommended.

Physical objects can be scanned with a 3D scanner to generate the **.stl** file. This can be done with a dedicated scanning device, but there are mobile phone apps with limited capabilities. <https://all3dp.com/2/3d-printing-apps/>

It is possible to convert photographs into **.stl** files that can be 3D printed.

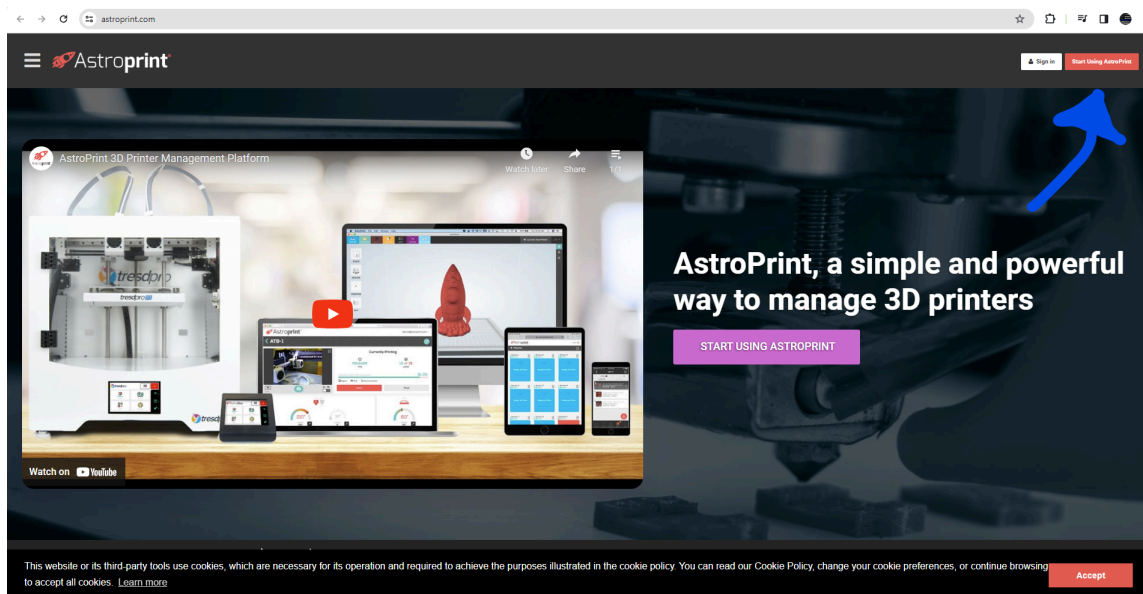
Another source of files is to start with an existing file and modify it.

Slicing Software

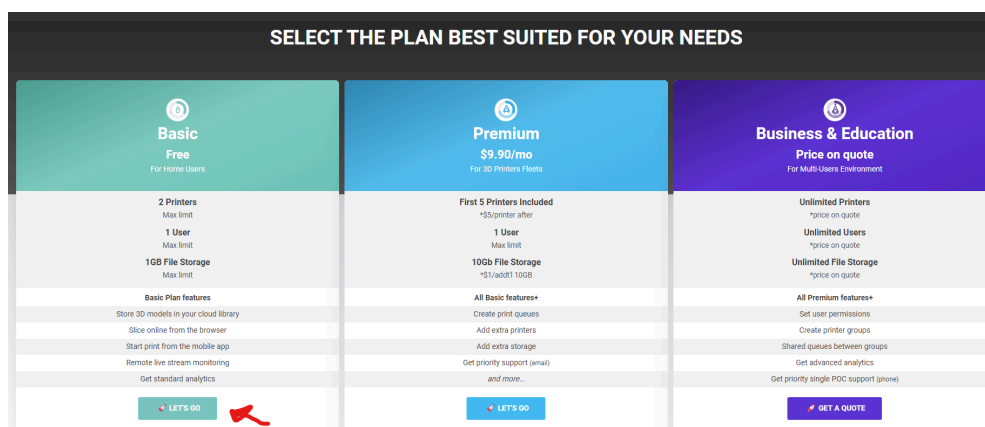
3D printed objects are essentially stacks of layers. The layers are created using slicing software that processes the .stl file that defines the object. The layers are on the order of 0.15 mm thick.

Slicing software converts the .stl file (defining the object to be printed) into the GCode commands that drive the specific 3D printer. Different 3D printers need different GCodes because their designs and configurations are different.

The slicing software that we will be using is **AstroPrint**. To access the software simply search in the task bar of Google *AstroPrint*. After selecting the website link you will be presented with the following screen. At this point you will want to select “Start Using AstroPrint” in the upper right hand corner.



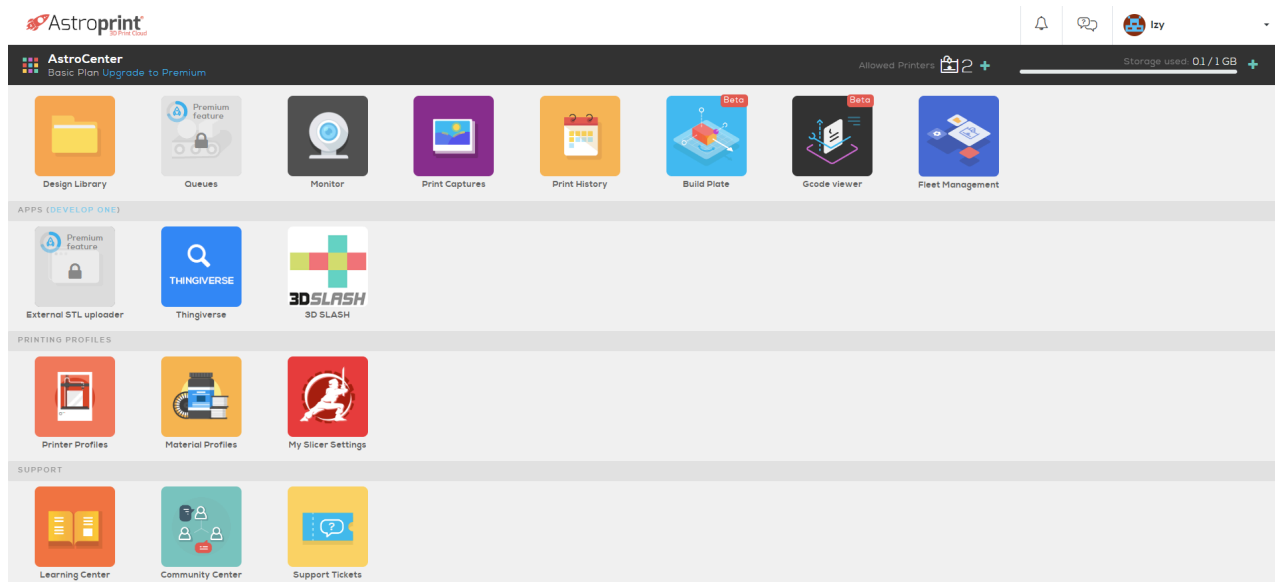
This program is free to use unless individuals wish to upgrade for more storage space. For beginners and our specific purpose the basic *free* plan will be sufficient. With that being said you can select the “Let’s Go” button at the bottom of the basic plan.



At this point you will be prompted to create your own personal account that you will be able to access at any point when working on a project. To login any other time after creating your account you will go through the same steps but instead of creating an account you will click the small blue “Sign In” letters at the bottom.

You will now have access to all the AstroPrint features. There are many useful components within the program. The main one being the slicing software. Within these instructions we will be strictly focused on that component. If you are interested in learning more about the AstroPrint software features visit the following youtube video; *@MakeWithTech - Astroprint 3.0 Best 3d Printer Software for Beginners.*

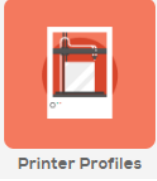
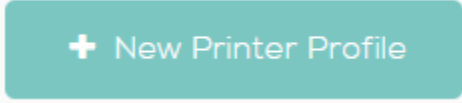
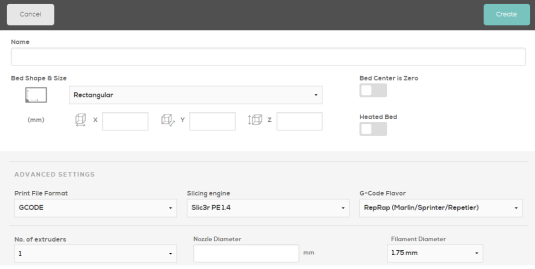

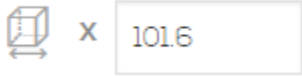
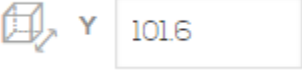

When creating an account and using AstroPrint for the first time it will ask you “How Are You Going to Connect Your 3D Printer?”. This prompt is asked due to the fact that you could set up the 3D Printer to print directly from the computer however, we will not be doing that. In the lower right hand corner you will select “I’ll decide later”.

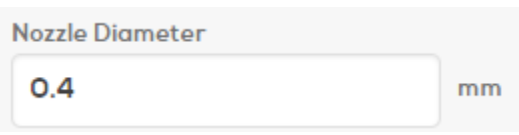
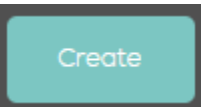


The screen shown above is the AstroPrint user home page.

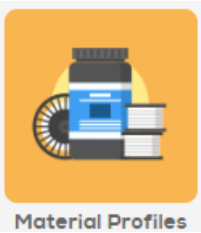
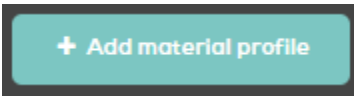

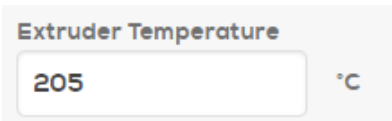
Upon creating an account there are some first time setup that needs to be completed prior to having a successful print. These steps only need to be completed once, since they will be saved for future use.

Printer Settings Setup

1	By clicking on the “ Printer Profiles ” icon you will be able to add the EasyThread K7 3D Printer.	
2	Select “+ New Printer Profile ” at the top of the page to continue the process.	
3	At this point you will be asked to select the printer manufacturer however, AstroPrint does not have the EasyThread K7 on file. With that being said, select the “ Create Custom Printer Profile ” option.	
4	You will be brought to a screen where you can import all of the printer's information.	
5	There are five simple steps that need to be done at this point.	
6	First; decide on a name for your printer.	
6	Second; insert the dimensions of the width of the X axis in millimeters (mm). This number will be 101.6	
7	Third; insert the dimensions of the length of the Y axis in millimeters (mm). This number will be 101.6	
8	Fourth; insert the dimensions of the height of the Z axis in millimeters (mm). This number will be 101.6	

9	NOTE: 101.6 millimeters = 4 inches	
10	Fifth ; insert the nozzle diameter in millimeters (mm). This number will be 0.4	
11	In the bottom or upper right hand corner you may select the “Create” button.	
12	Now you have your printer settings set up!	

Material Settings

1	By clicking on the “ Material Profiles ” icon you will be able to set the correct temperature for the EasyThread K7 3D Printer.	
2	Select “ + Add material profile ” in the top right hand corner of the page to continue the process.	
3	At this point you can name the material “PLA”. PLA stands for <i>polylactic acid</i> which is plastic in layman's term.	
4	Then the Extruder Temperature needs to be set to 205 degrees celsius.	
5	Select “Create” and you are done!	

The best printing temperatures for PLA with the Easythread K7 is **200 to 210 °C**. Maintaining the correct print temperature is vital for achieving high-quality 3D prints. If the temperature is set too high, above 210 °C, you may experience issues with stringing and oozing.

The **extruder** is one of the most important components on a 3D printer. It is responsible for sending the correct amount of filament to the hot end where it’s melted and extruded down in thin layers to make your part. It’s important to note that the extruder is not the same as the

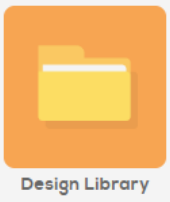

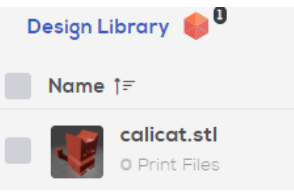


hot end, though these terms are commonly conflated.

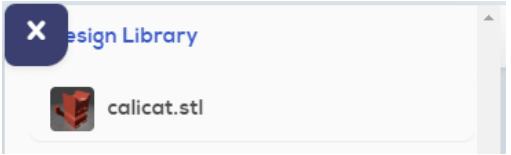
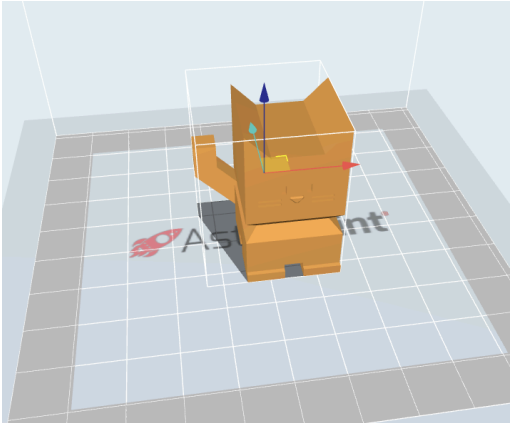
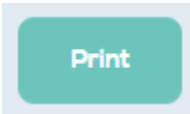
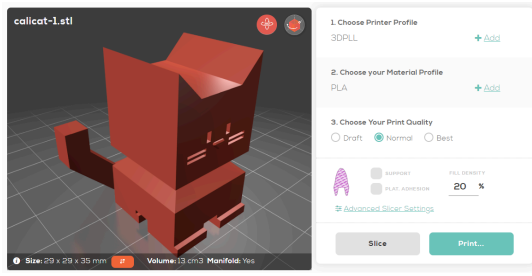
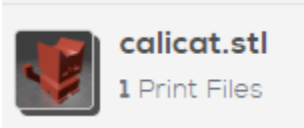

Uploading & Exporting Files

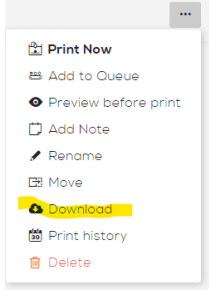
Uploadable files can be found on Thingiverse, created in Tinkercad, or found elsewhere. For more information on where to source files refer back to the “3D Printable Files” section of this manual. The overall goal of this whole process is to convert the .stl files into GCode files.

STL Files - An STL file describes a raw, unstructured triangulated surface by the unit normal and vertices of the triangles using a three-dimensional Cartesian coordinate system.

GCode Files - A GCODE file contains commands in G-Code, which is a language used to describe how a 3D printer should print a job. It stores instructions in plain text with each line representing a different command, such as how fast the printer should print, the temperature it should be set at, and where the printing parts should move.

1	On the AstroPrint home page select the "Design Library" icon.	
2	At this point you can click on the “Upload Files” button and select the file you already downloaded.	
3	Upon selecting your desired file to be uploaded it will be added to your design library.	
4	At this point you will want to return back to the AstroPrint home page and select the “Build Plate” icon.	
5	In the upper left hand corner is a plus icon that allows you to add a design onto the build plate. See attached image.	

6	<p>All your .stl files will be shown within your design library and you will be able to select your desired file.</p>	
7	<p>Once the object appears in the AstroPrint build plate, a single click on the object will allow parameters to be changed, such as dimensions, position, mirror imaging, etc. With each adjustment, the time and amount of filament required are calculated.</p>	
8	<p>When done making adjustments click "Print" in the lower right hand corner.</p>	
9	<p>At this point you will be brought to the page where the slicing and final steps will be completed.</p> <p>For the majority of prints the Normal print quality will be sufficient.</p> <p>Now select "Slice".</p>	
10	<p>After slicing your object you will be taken back to your design library. Here you will find your original stl file with 1 print file ready.</p>	
11	<p>By clicking on the objects stl file you will be presented with the GCode file.</p>	

12	To download the GCode file click on the three small dots on the right and click download.	
13	The GCode file will be saved in the location of your choosing. You will then have to put it onto the memory card.	

Other Resources

Many resources, such as Google and YouTube searches, are available to help 3D printing beginners.

The host technical support person may be able to help when questions arise or issues are encountered. That person should have access to a larger local network of people with knowledge and experience.

One of my favorite specific sites is: <https://all3dp.com>. This site has a search feature and it was used to create some of the links previously included in this document. It is possible to sign up for periodic emails that offer information on a variety of 3D printing and other topics, such as laser engraving, CNC routing, and more.

Another fun resource is <https://www.instructables.com>, with 3D printing being found at: <https://www.instructables.com/howto/3D+printing/>

Next Step?

If you think you want to continue with 3D printing after returning this kit, you'll have some choices. One is that you can use a 3D printer at one of the local makerspaces. See the image below for information on a number of makerspaces in the Wayne County area.

<p style="text-align: center;">The University of Akron Wayne College 3D Lab</p>	<p style="text-align: center;">330-684-8722 tjh1@uakron.com wayne.uakron.edu/3dlab</p>
<p style="text-align: center;">Apple Creek Historical Society Makerspace</p>	<p style="text-align: center;">330-778-0077 applecreekhistoricalsociety.org</p>

Romich Foundation Makerspace	330-464-7877 or 330641-5654 bromich@aol.com or izy.meshew@gmail.com www.RomichFoundation.org
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You may decide that you want to have a 3D printer at home. Our recommendation for beginner printers are the Ender Three 3D Printers. Schantz Makerspace offers 3D printer build classes, which are typically two consecutive Saturday mornings. More information is available at <https://www.schantzmakerspace.com/>. An advantage of this approach is that many local people have one of these and can help as needed.

Or you may have a friend who has a 3D printer that you can use. Some people have found that they are able to pay for their 3D printer by making and selling items.