

Getting Started with 3D Printing

Barry Romich, P.E.
PRC-Salttillo and Romich Foundation

Izabel Meshew
Romich Foundation Makerspace

4-11-2022

Note: The most recent version of this document is available at <http://RomichFoundation.org/3DPLL>. The version that is on the desktop of the computer that is part of this package 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 11. 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.

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 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

Windows computer loaded with software and other resources for initial success and some filament. This is being made possible through the donation of Windows touchscreen computers, keyboards and 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 X1. This 3D printer uses PLA filament and has a working volume of about a 4" cube. Other 3D printers may be used. Here is a video introduction to the initial model: <https://www.youtube.com/watch?v=Df3tDtfwWAA>.

3D printing can be done with a range of technical level. Now would be a good time to review the following, which comes with the EasyThreeD model X1 printer. The referenced manual is also on the computer desktop.

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 mitigations systems.

Fire Safety

As with most devices that involve elevated temperatures, the potential for fire exists. While there is no awareness of 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. Computer and power supply
- c. USB Expander with these items connected
 - i. Keyboard
 - ii. Mouse
 - iii. Memory card adapter
- d. Two filament spools
- e. Computer stand
- f. Filament spool stand
- g. **Getting Started with 3D Printing** manual
- h. Zipper bag
 - i. EasyThreeD manual
 - ii. EasyThreeD card
- i. Empty zipper bag for scrap

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 X1 3D printer.



When originally purchased (Walmart.com; Amazon.com; etc.), the Easy3D Model X1 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 control box 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 in the control box. 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.) Press the HOME button on the control box. The extrusion print head assembly should move down. It should stop moving with a small distance between the nozzle and the bed plate.

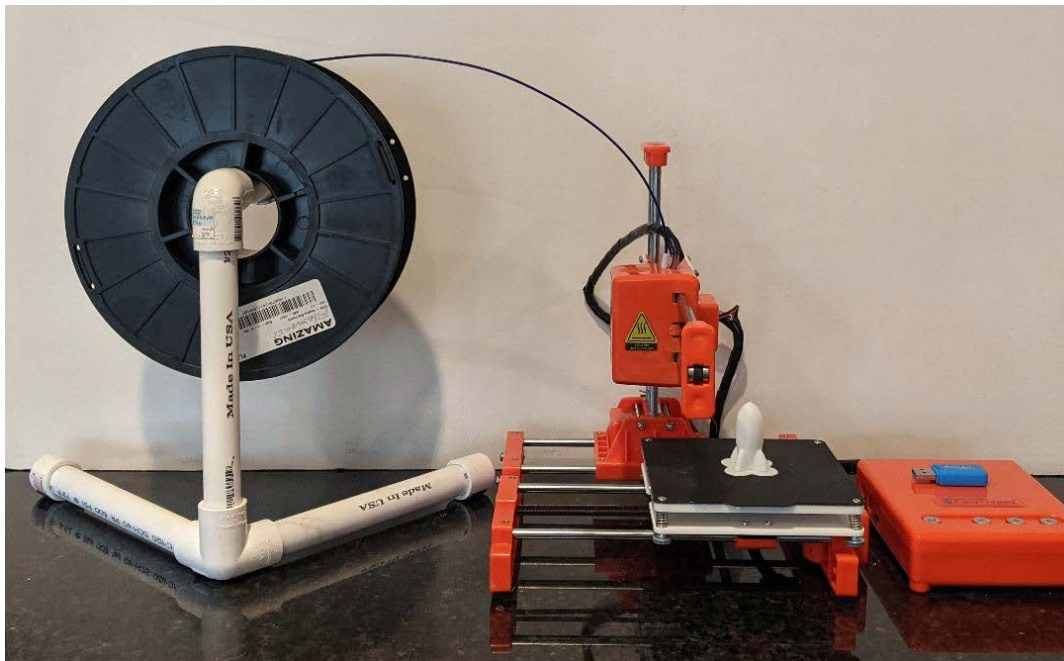
Disconnect the power. Carefully move the print head assembly and the plate so that the nozzle is near one of the corners. (This will take some force, so just be careful to push in the direction of the desired travel.) Now try to slide a sheet of paper between the nozzle and the plate. If the paper cannot be pushed into that space, turn the nut on that corner in the direction to tighten the spring. If the paper easily slides into that space, turn the nut on that corner in the direction to loosen the spring. When properly adjusted, there should be a slight drag when moving the paper in that space. Repeat this procedure for each corner. If adjustment was necessary, repeat this process.

Reconnect the power.

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.



Organize to have the end of the filament coming off the spool as shown. Press and release the **+** button on the control box. The light on this button will flash rapidly. This starts the process of heating the nozzle to the temperature needed for liquefying the filament for printing.

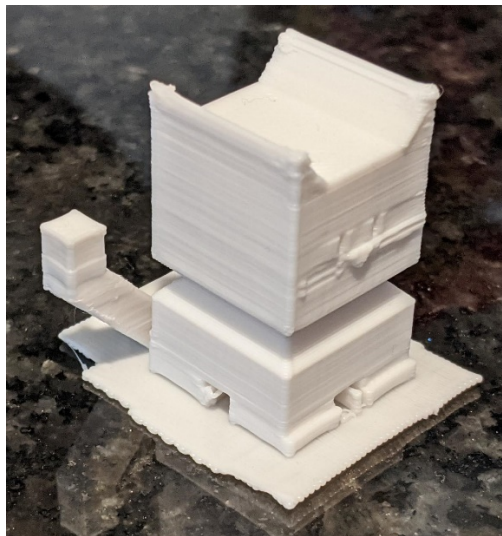
Caution: The nozzle temperature will reach about 200 degrees Celsius. This is hot enough to cause a burn on skin. Do not touch the nozzle when it is hot.

When the rapid flashing changes to slow flashing, the temperature has been reached and the motor that feeds the filament will begin turning inside the print head. At this time, feed the end of the filament into the end of the white Teflon tube on the top of the print head. Maintain a small downward force until the internal drive wheel has grabbed the filament and is drawing it into the print head. Watch the bottom of the nozzle and, when there is a stream of material coming out, press and release the **+** button again to stop the filament feed. The light should go out.

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 **calicat.gcode** file is on the card and so the result of this first printing process should be the calicat. This should take a little over an hour.



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 Windows 8.1 touch screen. It has only one USB port, so a USB port expander is included. This allows the keyboard, mouse, and FT USB card reader to be connected at the same time. Experience suggests that best results are achieved with the keyboard and mouse, as opposed to trying to use the touchscreen. 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 main limitation of this computer for this application is the 32 bit architecture, but it has been possible to work around that.

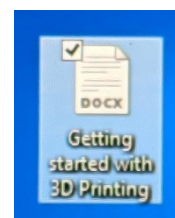


The computer is provided in a box to protect the screen during transport. A stand to hold the computer is included in the kit. Connect the power supply to the computer and then to an AC power outlet. Plug the USB expander into the USB port as shown. If the keyboard and mouse are not already plugged into the USB expander, do that now.

To turn on the computer, press the power button on the top edge near the right. The first task upon powering up the computer 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.



The computer desktop screen has a number of icons that will be useful. In the middle of the screen are three icons, including the file “Getting started with 3D Printing”, this document.



Next is the icon for the folder that contains the .stl files that you will download.



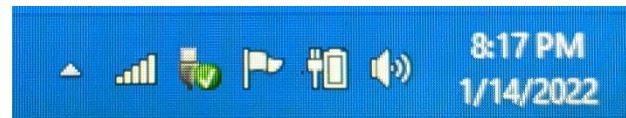
Next is the icon for the folder that contains the GCode files that you will download and/or create using the slicing software, Cura.



The taskbar is at the bottom of the screen. Near the left edge is the icon for the Google Chrome web browser. You may use this to search the Internet for information and/or files to print. Next is the icon for Cura, the slicer software. You'll learn more about Cura soon.



At the right edge of the task bar are icons for accessing the **wireless** network, preparing the memory card for being **ejected**, and adjusting the **volume** for when you're watching videos. (The volume can also be adjusted using the physical buttons on the left side of the computer, near the top.)



Before returning the kit, you may want to save any files that are stored in the folders on the desktop 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. Here is a six step tutorial:

<https://all3dp.com/2/tinkercad-tutorial-easy-beginners/>

Links to other 3D drawing programs and additional information can be found at:

<https://all3dp.com/1/best-free-cad-software-2d-3d-cad-programs-design/>

and

https://all3dp.com/1/best-free-3d-modeling-software-for-beginners/?utm_source=newsletter&utm_medium=email&omhide=true.

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.

<https://all3dp.com/1/free-stl-files-3d-printer-models-3d-print-files-stl-download/?s=photo%20to%20stl>

and

https://all3dp.com/2/3d-print-from-photo-how-to-do-it/?utm_source=newsletter&utm_medium=email&omhide=true.

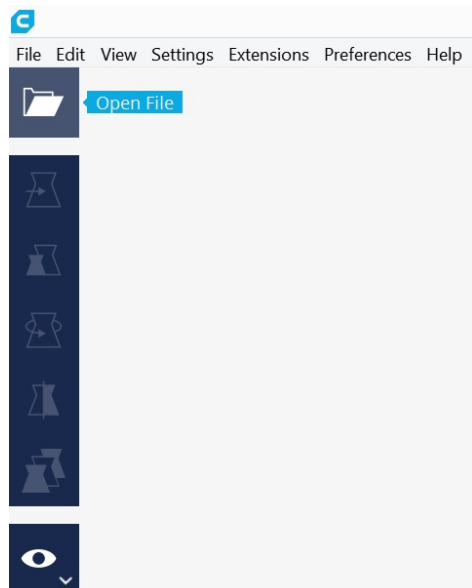
Another source of files is to start with an existing file and modify it.

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.

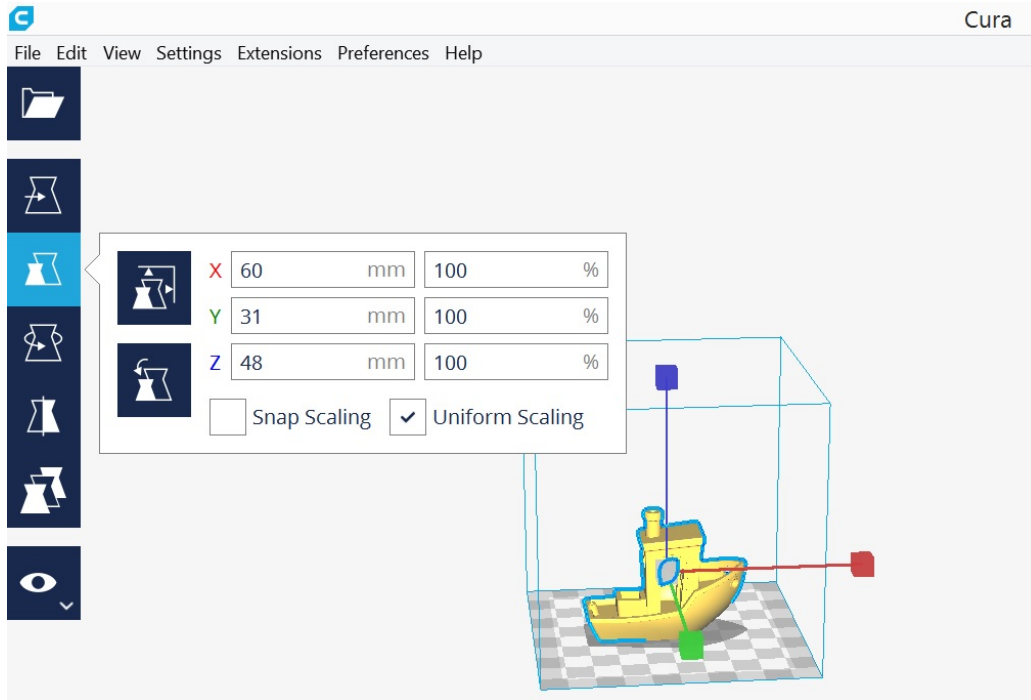
Slicing software converts the .stl file (defining the object to be printed) into the GCode commands that drive the specific 3D printer. Different 3D printers need different GCodes because their designs and configurations are different.

The computer in this kit comes with the Cura Version 4.8.0 slicing software installed. To start Cura, click on the Cura icon in the taskbar near the bottom left of the screen. (Use the mouse rather than trying to use the computer touchscreen.)

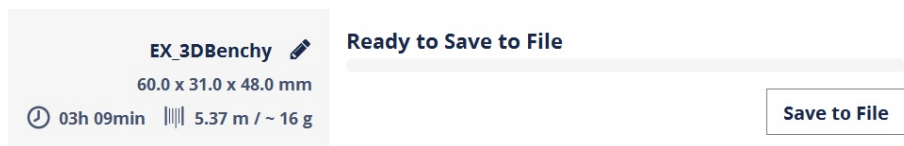


The EasyThreeD Model X1 3D printer includes slicing software. Cura is being used with this kit because an earlier version of Cura is available that will run on this 32 bit Windows 8.1 computer.

After starting Cura, click on the **Open File** icon to select the **.stl** file to be converted to GCode.



When the object appears in the Cura window, 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. In this example, it will take 3 hours 9 minutes to print and 5.37 meters (~16 grams) of filament will be used.



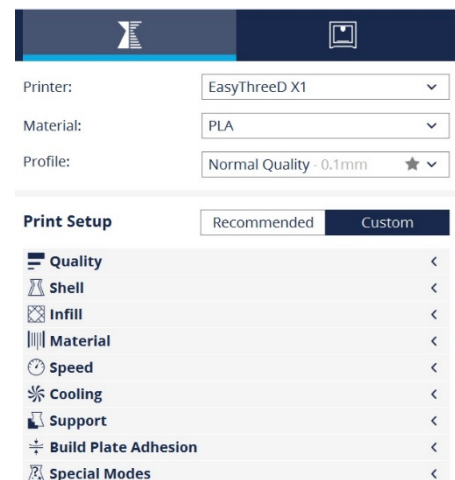
The time could be shortened by making the object smaller.

When ready, click on **Save to File** and the GCode will be saved in the location of your choosing, such as directly on the memory card. Then put the memory card in the control box, power up, and press **PLAY**.

Cura provides for many parameters to be adjusted. For example, changing **Quality** from **Normal** (0.1 mm per layer) to **Low** (0.15 mm per layer), would reduce the print time to about one hour for this example. It would not be advisable to make changes of this nature until experience has been built.

Cura is available for download at no cost. Here is a Cura tutorial:

<https://www.youtube.com/watch?v=eUNTIb5pEWA>.



Other Resources

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

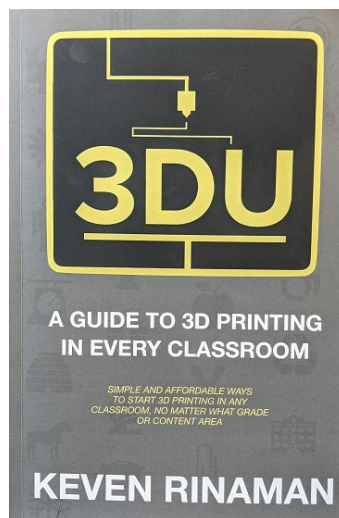
The host technical support person may be able to help when questions arise or issues are encountered. That person should have access to a larger local network of people with knowledge and experience.

One of the 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/>

For Teachers

One of the resources for teachers that was brought to our attention is the book 3DU.



It has many ideas for incorporating 3D printing into the classroom. A copy is being provided to the contact person for each school receiving one or more kits.

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. [Click here](#) for information on a number of makerspaces in the Wayne County area.

You may decide that you want to have a 3D printer at home. Here is a source of information that could be useful in making a good decision:

<https://all3dp.com/1/best-3d-printer-for-beginners/>.

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.

Troubleshooting, Getting Help and Sharing Help

Occasionally things will not go according to expectations. Many resources are available, including some mentioned earlier in this document. Since there are a number of these kits circulating in Wayne County, people who have had experience with them can be a place to turn.

- 1) If you are willing to be a resource, please send an email message to 3DPLL@gmail.com.
- 2) If you are needing help, describe your issue in a message to 3DPLL@gmail.com. We may have a resolution ready, but if not we can share your issue with those on the list willing to help.
- 3) Commonly experienced issues are documented and posted at <http://RomichFoundation.org/3DPLL>.

Local Host Site

While Romich Foundation provides overall support, local administration is being hosted by various organizations. The hosting organization identifies an administrative contact person and a technical lead, who should be able to help resolve any technical issues.

For this kit, the local host site is _____,

and the technical lead is _____.

The Romich Foundation contact is:

Barry Romich, P.E.
Romich Foundation
13875 Cleveland Road
Creston, OH 44217

330-464-7877

bromich@aol.com

[Romich Foundation](#) maintains a modest makerspace (high tech shop) that is generally open to the community, and you are invited to make contact if you'd like to schedule a visit.