

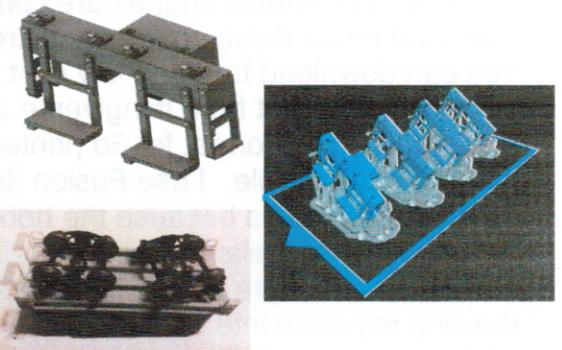
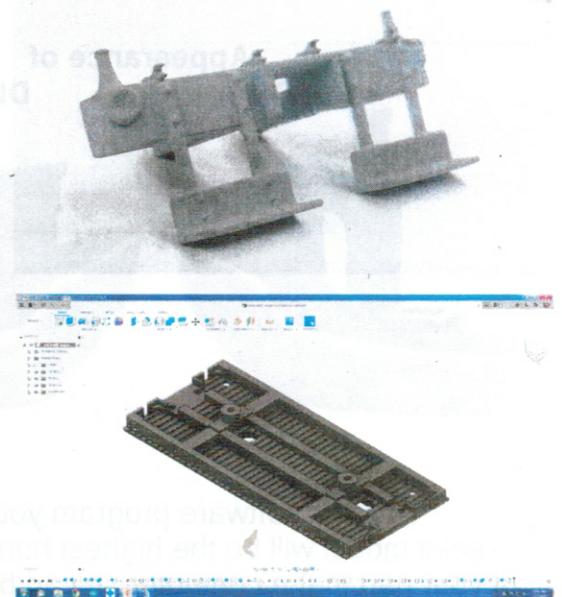
# Basics of 3d Printing, Part 1

By Ken Mosny

3d printing of model parts is rapidly being introduced as a way of making models in our hobby. In the last few years, the price of DLP resin printers has dropped dramatically putting the technology within reach of the average modeler. For the cost of a sound equipped locomotive, about \$300, you can do this at home or for less if you want to use a print service, like Shapeways®. The main hurdle, in my view, is to learn how to create the computer models of parts with solid modeling software. Fortunately, I jumped this hurdle in my day job long ago solid modeling for the machine tool industry. There is free solid modeling software, I use fusion 360 on a free hobbyist license, and there is lots of how to information on the internet to help you learn. Once you master the skill of solid modeling, you can probably make exactly the part you want in the same amount of time needed to make it using conventional methods and probably with better results. Of course, multiple copies are easy.

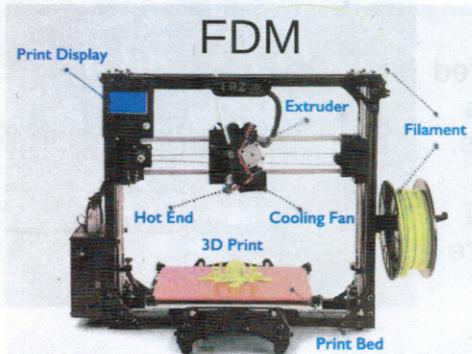
## Why should I do This?

- 1 You can have exactly the part you want without settling for close.
- 2 You can make many copies with little effort.
- 3 You can usually print a part with less effort than making it by conventional means with detail at least as good, probably better.
- 4 You can easily modify of the shelf models.



## FDM vs DLP Printers

There are two kinds of printers marketed for the hobbyist, at least for those of us who don't have 4 or 5 figures to spend on one. They are the FDM, **F**usion **D**eposition **M**odeling, and the DLP, **D**igital **L**ight **P**rocessing, printer. They both have pros and cons so one is not necessarily the "best". However, because the DLP printers have far superior surface detail they are focus of this clinic and best for modeling most detail parts.

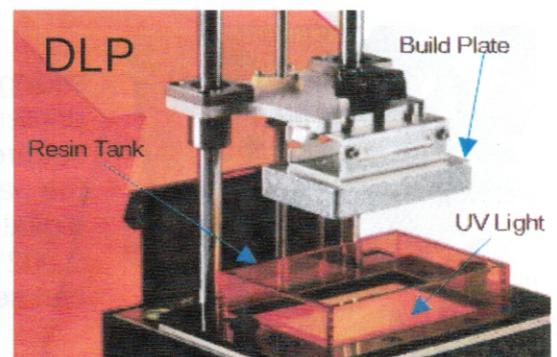


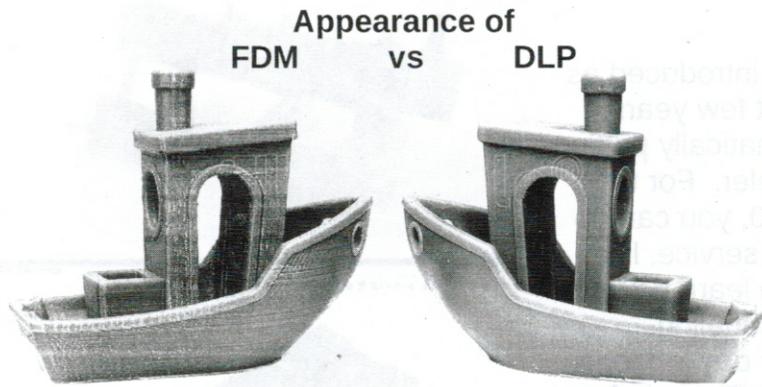
## FDM Printers

An FDM, **F**usion **D**eposition **M**odeling, printer squirts melted plastic filament out of a nozzle that moves around to build an object on the print bed. Their chief advantages are there are no toxic chemicals, the prints can be quite strong, they have a large print volume for the buck, and they are fun to watch (think kids at school). Strength and range of materials are good, but, unfortunately, detail and surface finish are poor for our purposes.

## DLP Printers

A DLP, **D**igital **L**ight **P**rocessing, printer creates a part layer by layer on the bottom of a build plate. The build plate is lowered in the resin tank where a thin layer of resin is hardened by the UV light under the bottom of the tank. The build plate is lifted a minute amount and another layer is hardened until the part is finished. The parts have very good surface detail and smooth finish. Strength and flexibility of the parts can be to urethane resin kits which is to say, limited.





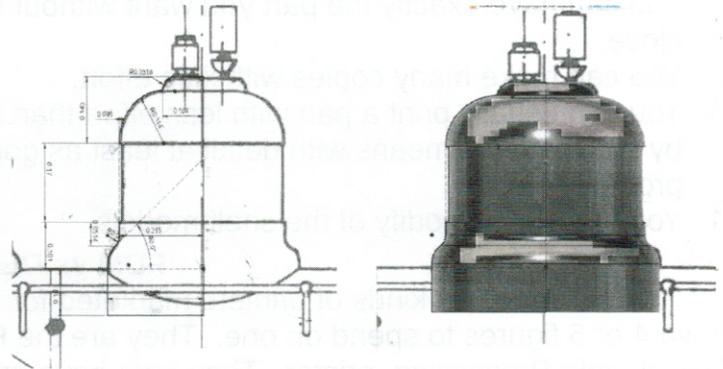
At present DLP UV resin printers are, in my opinion, the only high resolution printers affordable for the home hobbyist at this time. This will probably change as the other technologies lower in cost. Remember that screen pixel size determines print detail not 2K, 4K, etc. Low cost printers, like mine, have a pixel size of about  $50\mu$  or  $0.002''$ . Recently the, pixel size has decreased to as small as  $18\mu$  or  $0.0007''$ . This means that the smallest feature that can be theoretically printed is  $0.0007''$  in size

### Solid Modeling Software

The first software program you need is a solid modeling program to create the parts. Learning to solid model will be the highest hurdle for most most people. A solid model is a virtual representation of your part in the computer. It can be rotated and even cut to look at it in detail. In general, drawings called sketches are made and then extruded to create simple solid shapes like blocks, cylinders, and spheres. The simple shapes are combined to make more complex models. The software has tools to copy and move these shapes and create more complex shapes like curve bodies.

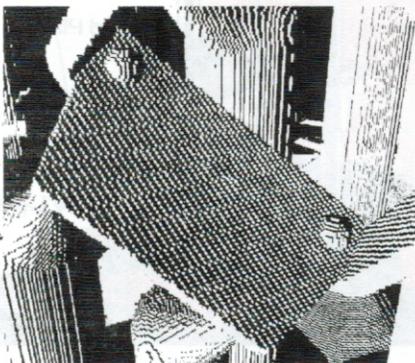
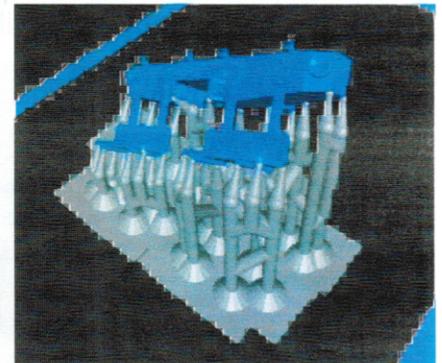
You can download free and low cost solid models if you want from thingiverse and others. The standard file format for 3d printer solid models is the .stl file. I use Fusion 360® to create solid models because the hobby license is free and it is similar to Solidworks® which I used at work. Here is how I used a locomotive drawing imported into Fusion 360® to trace the profile of a steam dome. The traced sketch is then revolved to create the solid dome.

There are lots of tutorials on the internet to help you learn to use this software.



### Slicing Software

The solid .stl file is then opened with slicing software to be prepared for printing. Free Chitubox® software, often supplied with printers, is what I use. I design models full scale and assign the desired percent printing scale as the file is opened with Chitubox®. S scale is 1.56%, for example. The slicing software is used to do two operations. First is to add supports to hold the part during printing. The parts are weak having not been fully cured during printing so they need support. The supports are created automatically by just clicking the place where you want to add the support. This software is very easy to use.



Next, the solid model is sliced into pixel sized cubes. The slicing is an automatic process by specifying a few parameters. The printer is actually exposing the resin to the UV light through tiny squares, pixels, in the screen so the DLP printer is actually creating the part by curing tiny cubes of resin. The slicing process defines the digital location and size of these cubes. The cubes are  $50\mu$  or about  $0.002''$  on a side for my printer and usually  $50\mu$  tall. Sometimes you can see tiny ridges on a part, but paint fills them in.

The final sliced file is transferred from the computer to the printer on a thumb drive.