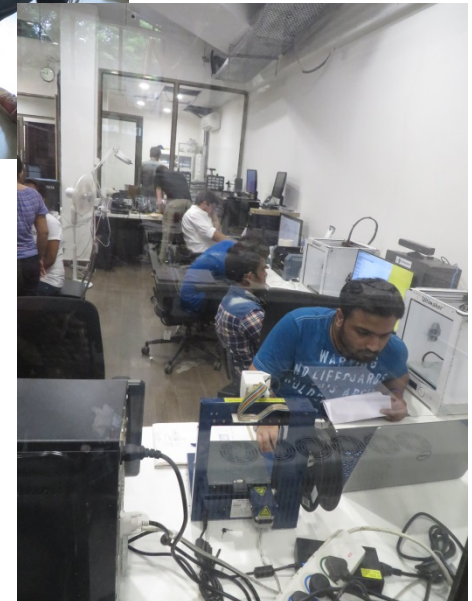


Summary of FabLab Digital Fab Machines and Software Options

FabLab Equipment List

- ShopBot CNC
 - Dust collection
- Laser Cutter
 - Blower for ventilation
- Roland mini mill
- Roland vinyl cutter
- 3D printer (thermoplastic)
- Electronics
 - Soldering stations including venting
- Molding and Casting
 - Toaster ovens and crucibles
 - Different molding supplies
- Computers
- Storage



FabLab Equipment List

comparison of different Digital Fab tools

http://www.shopbottools.com/mMarkets/digital_fab_equipment_comparison.htm

Good Harbor Bay Warm Glass ... Digital Fab Equipment Com...

File Edit View Favorites Tools Help





Southwest Airlines Book ... plugs for 220 - Google Sea... Suggested Sites Toshiba App Place Web Slice Gallery

Products Applications Support News Events About Us future.

Digital Fabrication Equipment Comparison Table

You can think of digital fabrication machines as working in one of two manners: subtractive or additive.

- Subtractive machines start with a large block or piece of material, and machine, mill or cut the material until the parts are the size and shape you want.
- Additive machines start with nothing, and lay down or extrude material to build up the object into the final product. often, the term rapid prototyping is used when describing the technique of building up or adding material to achieve the final "printed" product.
- 3D printing is another term that is often used for additive machines, but traditional "subtractive" machines can also produce 3D objects, often more efficiently and using more kinds of materials than 3D additive printers.

Type of Machine	"Traditional" CNC router or milling machine	Laser Cutter	Vinyl Cutter/ Cardboard Cutter	3D Printer, Additive
Subtractive or Additive	Subtractive	Subtractive	Subtractive	Additive
How it works	Uses a spinning router bit to machine away material from a larger block or sheet.	A laser beam is directed at the material, which then either melts, burns, vaporizes away, or is blown away by a jet of gas.	Uses a knife blade rubbing or rati to cut out sheet material.	Lays down layers of a softened material or powder to build up an object in 3D.
What can you do with the machine?	<ul style="list-style-type: none"> Machine or cut out flat sheets of material to any depth (G0) Engrave in 2D Machine in 3D 	<ul style="list-style-type: none"> Etch the surface of flat materials Burn or cut materials 	<ul style="list-style-type: none"> Cut sheet material into 3D parts 	<ul style="list-style-type: none"> Build up intricate 3D parts
Samples of objects made with the machines				
Where they shine	<ul style="list-style-type: none"> Making precise, complex or 	<ul style="list-style-type: none"> Etching on glass, fabric, metals 	<ul style="list-style-type: none"> Cutting out vinyl lettering and 	<ul style="list-style-type: none"> Creating objects with

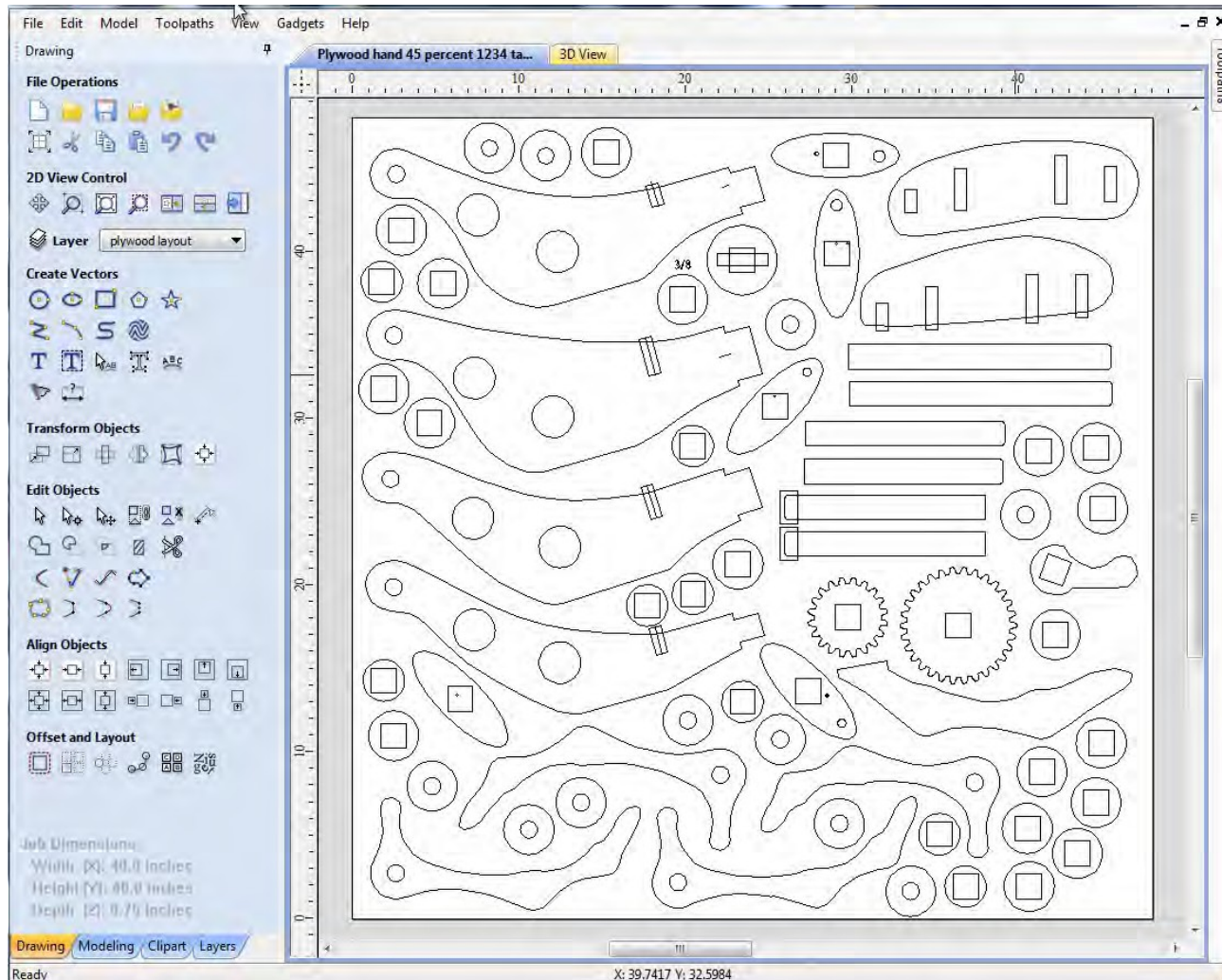
5:45 AM 2/16/2016

http://www.shopbottools.com/mMarkets/digital_fab_equipment_comparison.htm

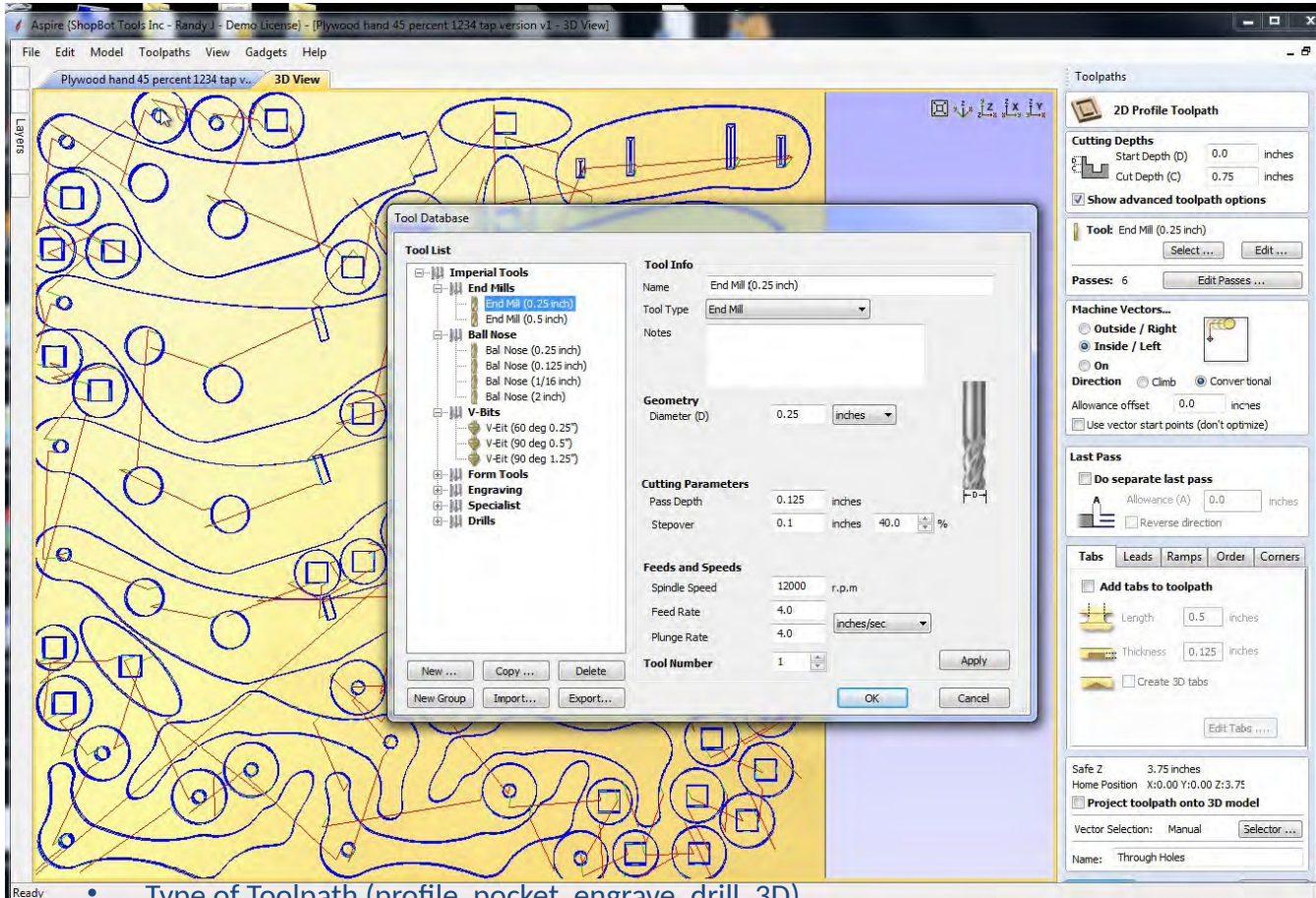
Digital Fabrication Workflow

- CAD Computer-Aided-Design
 - What and Where
- CAM Computer-Aided-Machining
 - How
- Controller: writing the machine code
 - ShopBot code = .sbp
 - G Code = .nc
 - Hidden code (laser, 3D printer, desktop printer)
- Machine set up
 - Zeroing machine in X, Y and Z
 - Hold down for CNC machining, turn on dust collection
 - Preparing extruder for 3D printing
 - Turning on air cool and ventilation for laser

CAD – What and Where



CAM – How For CNC machine



- Type of Toolpath (profile, pocket, engrave, drill, 3D)
- Characteristics of router bit (Size and Shape: end mill, V bit, ball nose)
- Feeds and speeds
- Toolpathing strategy (depth of cut, contour vs raster, cut direction, etc.)

CAM – How

For other machines

Laser Cutter: (Type and thickness of material)

- Raster vs. vector
- Speed
- Power

3D Printer

- Rate
- Quality: How much plastic to extrude

Vinyl cutter

- Pressure (thickness of material)

Actual code hidden in many machines

CONTROLLER for Machine

Where to go next in X, Y and Z

Speeds and Feeds, Turn on and off device such as router, laser or extruder

G-CODE (.nc)

(Program Name-Profile 1)

M98PSTRTIME.SUBL1

G90

SET ZSHIFT = ?

(Enter Material Thickness)

G09F8

G52L1

S12000

T1 M3

(End Mill (0.125 inch))

G0 X0.000 Y0.000

G00 Z24.130

M31

G00 X34.412 Y120.435 Z5.080

G01 Z-3.000 F1524.0

G01 X226.301 F4572.0

G01 Y223.587

G01 X34.412

G01 Y120.435

G00 Z5.080

G00 Z24.130

G990

G90 G0 Z0

X0. Y0.

M5

M98PENDTIME.SUBL1

M02

SHOPBOT CODE (.sbp)

MS,75.9,25.3

JZ,24.129999

J2,0.000000,0.000000

J3,106.728844,281.529694,5.080000

M3,106.728844,281.529694,-6.000000

M3,106.728844,381.644775,-6.000000

M3,255.045303,281.529694,-6.000000

M3,109.903847,278.354706,-6.000000

M3,106.728844,281.529694,-12.000000

M3,106.728844,381.644775,-12.000000

M3,251.870300,384.819763,-12.000000

Note: ShopBot will read G-code or convert
G-code to ShopBot code

(All values here set to mm.
Codes can be saved as mm or inches)

Set up for Machine

Place Material in best place

- CNC: Hold down the material with screws, tape, vacuum or jig
- Laser: place on bed...no hold down, check for waviness of material
- 3D Printer: anchor print to bed
- Vinyl Cutter: load material, will rollers hold down material for cutting?

Set up for Machine

Zero the X and Y the same way as CAD file (set origin)

- Tradition
 - CNC: lower left hand corner
 - X value positive
 - Y value positive
 - Laser: Upper left corner
 - Like printing a document in US English
 - 3D printer: middle of design
- You can change the origin of the CAD file as long as you set up machine the same way as the CAD file

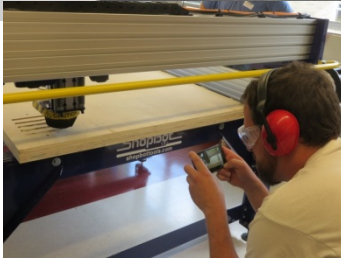
“Print” the design



Assemble the parts



Prototype a design



Example:

- Design furniture for ShopBot
- Scale design to test concept in cardboard using laser cutter
- Do a test of slot thickness to match plywood thickness
- Assemble press fit furniture without using hardware (screws, etc.)

CAD and CAM software

Many options including FabModules

CAD

Graphic based for printing:

Inkscape (free)

Corel Draw

Adobe Illustrator

Graphic based for CNC:

VCarve

3D Consumer

123D Design

Tumblr

SketchUp

TinkerCad

kokopelli

Engineering based:

Rhino

Inventor

Solidworks

Fusion 360 (free-ish)

CAM for CNC

Import to VCarve

Import to VCarve

Import to VCarve

Consumer

VCarve

DeskProto

kokopelli

Engineering based:

Rhino CAM

HSM

MasterCAM

Fusion 360

Driver for other machines

Driver for laser .pdf?

Driver for laser: vector and raster

.stl send to 3D printer

Import to VCarve

FILE FORMATS

2D Vectors:

.dxf

.dwg

.eps*

.ai*

.svg

.skp

.pdf*

* may contain both vectors (nodes and spans) and bitmap (color/fill) . Use vectors only for ShopBot.

Roland may use bitmap data for machining circuit boards, etc.

3D

.stl

.obj

Bitmap

.jpg

.png

.bmp

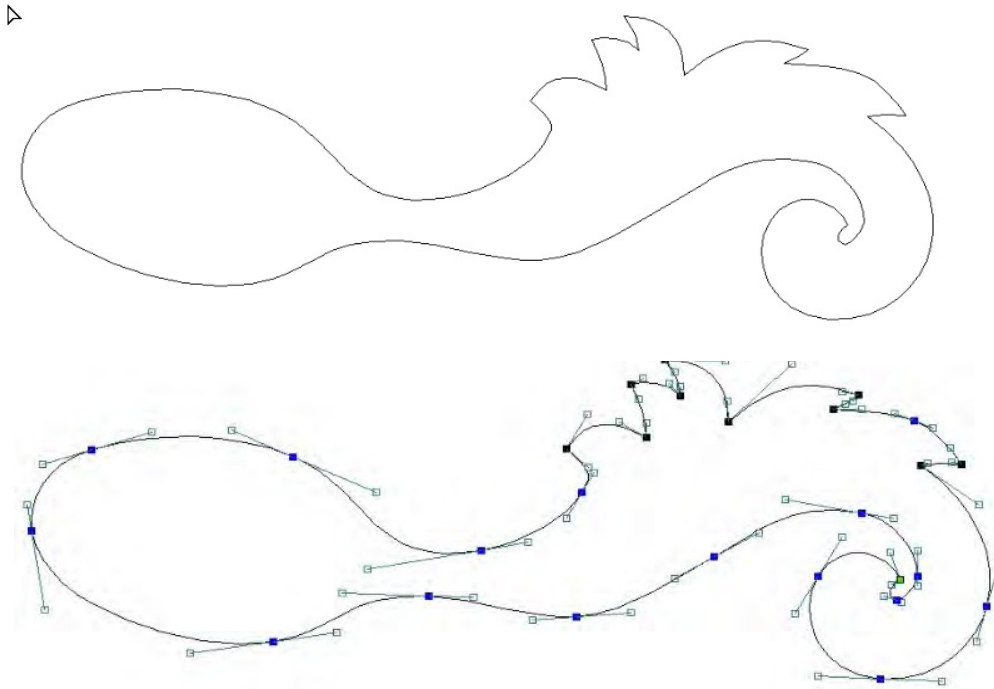
.tif

FILE FORMATS

2D vectors (.dxf , dwg, eps, ai, etc.)

Vector based designs (lines) are easy to manipulate

- A Vector drawing is defined by nodes and spans.
- A Vector can be scaled without loss of resolution



CAUTION:

A drawing from a graphics file that contains color has both vector and bitmap data.

Change fill to no fill to hide bitmap data.

FILE FORMATS

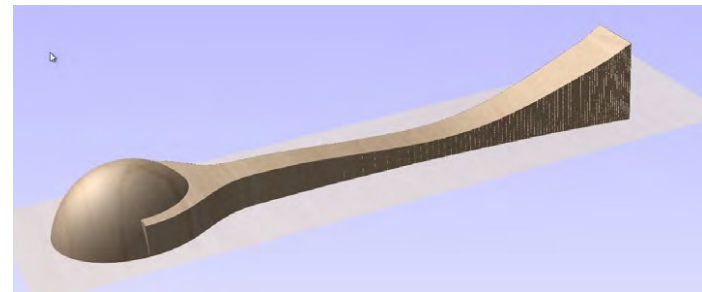
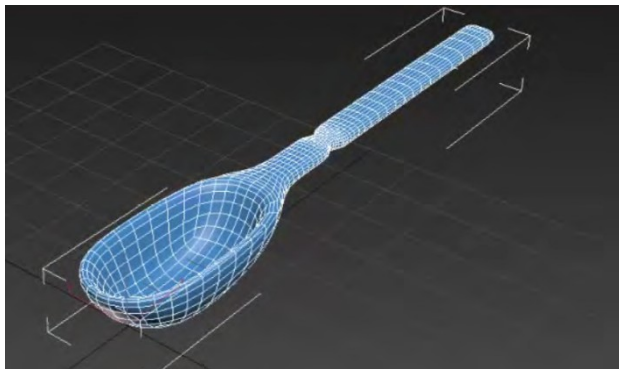
3D models (.stl, .obj)

Can be machined on CNC (subtractive) or printed on 3D printer (additive)

3D printer can print complex shapes

ShopBot 3 axis only...may have to flip material to machine both sides

A rotary indexer is available for machining in the round



FILE FORMATS

Bitmapped images (bmp, jpg, jpeg, png, tif, tiff, gif, some pdfs)

Do not scale well...resolution changes with scaling

For CNC: Must be traced and converted to vector lines, but provide a very useful starting point for some types of projects.

For laser: etching

For Fab Modules: CNC machining (Roland) or vinyl cutting

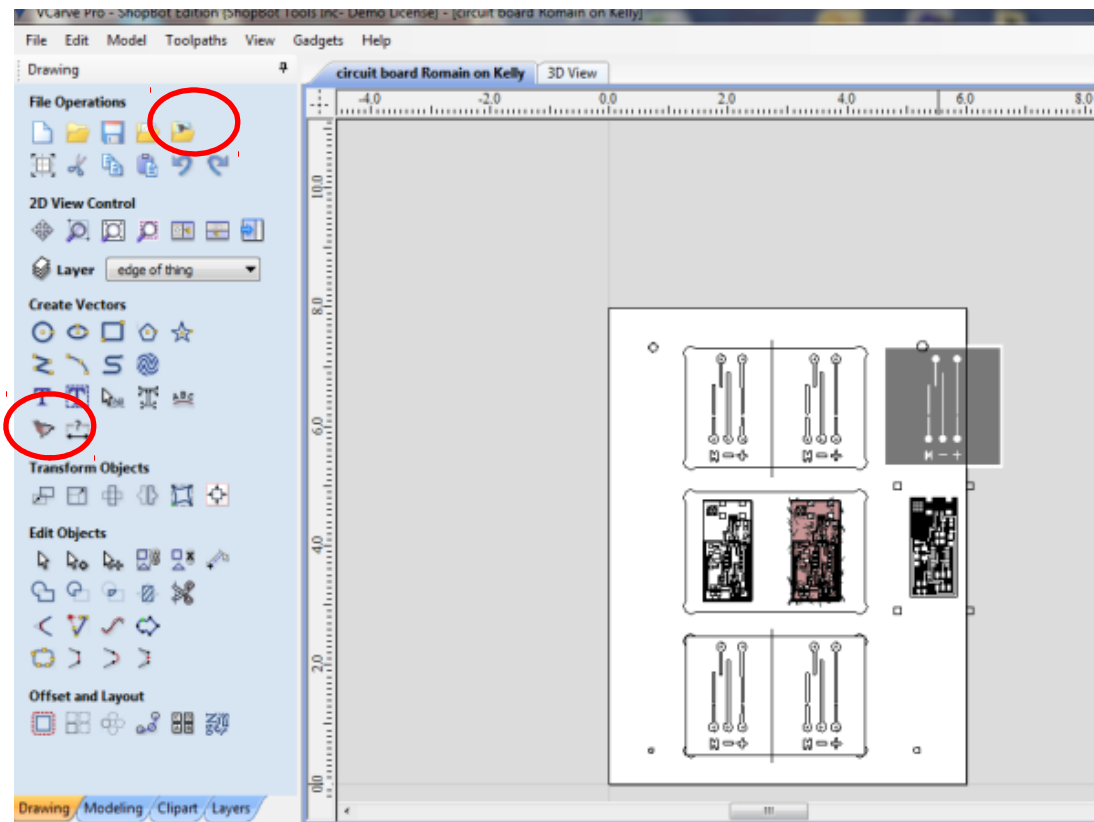


FILE FORMATS

Bitmapped images (bmp, jpg, jpeg, png, tif, tiff, gif, some pdfs)

Can be traced to create vectors in VCarve Pro for CNC machining on ShopBot

Must be used as bitmap in FabModules for Roland mill/Roland vinyl



Summary of FabLab Machines

- **Laser Cutter: Laser burning into material. Ventilate fumes to outside or through filters.**

- Types of tool paths
 - Vector (cut through material)
 - Raster (designs and photos etched into material)
- Able to laser
 - Paper/cardboard
 - Thin wood
 - Plastic
 - Yes to acrylic
 - No to PVC (creates chlorine gas)
 - No to HDPE (melting point too low)

- **ShopBot CNC: Spinning router bit. Use Dust Collection and Ear/Eye protection.**

- Types of toolpaths
 - 2D (Cut to one depth: end mill bit)
 - Engrave (Create engraved look in lettering, designs: V bit)
 - 3D (ball nose bit)
- Able to Machine
 - Wood and wood products: Plywood; Hardwood; MDF
 - Plastics (use correct bit and slower RPMs than for wood): Acrylic; PVC; HDPE
 - Soft metals (use correct bit and slower RPMs than for wood, sometimes use coolant): Aluminum; Copper/ Brass
 - Circuit boards: copper on phenolic (detail depends on model of ShopBot)
 - Machineable wax
 - Plaster and other mold making materials such as pressed vermiculite and Ceramaguard™ (use good dust collection and respiration masks)

- **Roland mini mill: Spinning router bit. Creates “dust”...use eye and ear protection as needed.**

- Same as ShopBot... better for smaller, more detailed work
- Uses FabModules, so different preparation for machining files

- **Roland vinyl cutter: sharp blade to cut material**

- Types of tool paths
 - Vector (cut through material)
- Able to cut
 - Paper/thin cardboard
 - Thin copper backed with adhesive for creating circuits
 - Thin vinyl/plastic for creating stencils or lettering

- **3D printer: Extrudes plastic heated to melting temperature which can then cool rapidly to hold shape (thermoplastic)**

- Additive rather than subtractive...builds up material rather than machining or cutting or burning existing “block” of material
- Types of tool paths: 3D .stl or obj
- Professional 3D printers can print many other types of materials, including metals, combination rigid and flexible materials, etc.