

## Week 8: Computer-Controlled-Machining

18.3. 2015

This week we will learn about computer-controlled machining.

The agenda:

[http://academy.cba.mit.edu/classes/computer\\_machining/index.html](http://academy.cba.mit.edu/classes/computer_machining/index.html)

**machines** [Roland](#) [ShopBot](#) [Hurco](#) [Harrison](#) [Omax](#) [EDM](#) [MTM](#) **stock** rigid foam insulation (gesso, heat gun) veneer plywood medium density fiberboard (MDF) medium density overlay (MDO) oriented strand board (OSB) HDPE Lexan, polycarbonate Garolite aluminum **vendors** [McMaster-Carr](#) [Home Depot](#) [Admiral Metals](#) [Boulter Plywood](#) [Steritt Lumber](#) [Beacon Sales](#) **job shops** [Proto Labs](#) [Firstcut](#) [Cycle Start](#) [DHS](#) **tooling** drill bits vs end mills flutes coatings center-cutting up/down cut flat/ball end **speeds and feeds** chip load:  $\sim 0.001-0.010'' = \text{feed rate (inches per minute)} / (\text{RPM} \times \text{number of flutes})$  cut depth:  $\sim \text{tool diameter}$  step-over:  $\sim \text{tool diameter}/2$  **lubricants** **abrasive machining** **fixturing** vises clamps screws vacuum tabs weights adhesives tape encapsulation **squaring** **dust collection** **flexures, living hinges, kerfing** **toolpaths** kerf, offset, runout conventional, climb 2, 2.5, 3, 3+2, 5 [rough/finish cuts](#) cut depth, clearance, collisions t-bones lead-in, -out test cuts, cutting air [ShopBot VCarvePro](#) [FeatureCAM](#) [Mastercam](#) [HSMWorks](#) [Omax Layout](#) [fab modules](#) **file formats** .rml .sbp .g .ord **safety** [training](#) cuts, burns, impacts, fires glasses, shoes, clothes, hair don't reach into a powered tool emergency stop, assistance **welding** arc MIG (metal inert gas) TIG (tungsten inert gas) spot friction ultrasonic **assignment** make something [big](#)

**The assignment** for this week::

Make something big ☺

### Class:

We watched an interesting introduction of atfab.co – design company that designs furniture. They share their design on the open desk website: <https://www.opendesk.cc/designers/anne-filson> & <https://www.opendesk.cc/designers/gary-rohrbacher>

### Machines:

Introducing Shopbot: <http://www.shopbottools.com/products.htm>

### Stock:

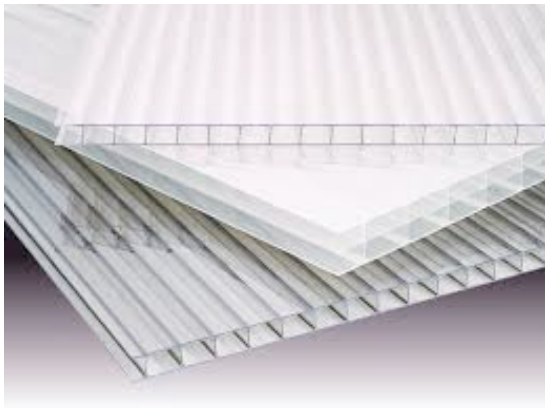
MDF – smooth surfaces



OSB (orientated Strand Board) – by far the cheapest



Lexan



Garolite



Aluminium

**Tooling:**

Drill bits go down  
Endmill go sideways

Machinery's Handbook:

<http://new.industrialpress.com/machineryhandbook>

**Lubricants:**

Metalworking fluids: <http://www.mcmaster.com/#machining-lubricants/=wd317g>

Helps the cutting area

Abrasive machining: <http://www.mcmaster.com/#abrasive-powders/=wd3mod>

Fixturing:  
Vises  
Clamps  
Screws  
Vacuum  
Tabs  
Weights  
Adhesives  
Tape  
Encapsulation

**Squaring:**

Cut out a square shape and make sure it is square  
Sacrificial underlayer

**Dust collection:**

Essential

**Flexures, living hinges, kerfing:**

[http://academy.cba.mit.edu/classes/computer\\_cutting/flexures.png](http://academy.cba.mit.edu/classes/computer_cutting/flexures.png)

**Toolpaths:**

Continuous flowing surfaces...

When you first do your job..prepare your job, get everything ready –  
and then cut air, to make sure everything is working properly

Rough/finish cut:

[http://academy.cba.mit.edu/classes/computer\\_machining/cuts.png](http://academy.cba.mit.edu/classes/computer_machining/cuts.png)

Fabmodules

Shopbot – design software:

<http://www.shopbottools.com/mProducts/software.htm>

.svg – you have to pick the resolution you are going to render at

.stl

Blender monkey

Open in the Shopbot controller

**File formats:**

.rml

.sbp

.g

.ord

There isn't a single standard g-code.

**Safety:**

Health and Safety training essential  
Many different ways you can get hurt  
The chips have sharp edges  
Watch anything that is sharp  
It is hot – like machining wood, the chips can catch fire  
Things can go flying  
The tools can shatter and go flying  
When machining wear safety glasses  
Need good shoes, for things dropping  
No loose clothing  
Hair tied up  
Never, ever reach into a power tool – turn it off first  
Before you start machining make sure you know where the emergency  
switch is for stopping the machine  
Never run a laser cutter, never leave a shotbot unattended to run,  
always work with a buddy

Digitally fabbed house: [http://blog.ted.com/digitally\\_fabbe/](http://blog.ted.com/digitally_fabbe/)

Milling out a frame of kajak

Open source furniture / Fab:  
<https://sites.google.com/site/fablabiceland/home/inspiration/open-source-furniture>

Living hinges swatches: <http://obrary.com/products/living-hinge-patterns?variant=798259727>

OpenDesk: a revolution in furniture design:  
<http://www.theguardian.com/artanddesign/video/2013/dec/20/opendesk-furniture-design-revolution-video>

Vcarve – software for preparation of cnc machining:  
<http://www.vectric.com/downloads/trial-software.html>

## **Assignment**

The Assignment is a stand-desk, which has inlaid plexiglass and is made of board?

It was modelled in Rhino without many problems. I did though run into some trouble with closing surfaces, but resolved those with capping and tweeking the parameters of tolerance.

The Rhino model was imported into vcarve. The file formats that can be imported into VCarve are:

Crv  
**Dxf**  
Dwg  
Eps  
Ai  
pdf

I saved each part of the model in Rhino as a dxf. file – Nameofpart. These .dxf files were imported into VCarve Pro – Shopbot Edition software.

Before starting the project is prepared by setting the size of the sheet to be cut, in mm.

Import – Import vectors – chose file...

The part was then selected by drawing a square around it with the mouse – and moved onto the sheet.

I had to select the parts and rescale them as the model was modelled in cm – from 100% to 1000%.

When importing the vectors the parts only seemed to import from mac Rhino.

Vcarvo Pro – work – describe

See Linda's notes

Machining preparation – Images

Tool: ¼" Straight (48-005)

Setting and calculating toolpaths – Profile toolpath (for cutting outside the objects) and Pocket toolpath (for pockets)

Creating Fillets – Tool Radius: 3.175 mm

T-Bone Fillet (These fillets are used for creating a clearance in internal corners when the slot is the same size as the tool)

### **Shopbotting**

Screw sheet down, screw in each corner

Insert tool

Check clearance in corners

In Vcarve Pro - Transform object – Move selection

Z zero was set at the bottom in lower left corner of the sheet

Recalculating toolpaths: Tools – Recalculate all toolpaths

Save toolpaths to control computer

Set z axis 0 to the sacrificial layer

Set x and y to corner of sheet

Cut part – open toolpaths

Chose file

Enter key in machine

Put on goggles

Hit the start button