How to Build a CNC Machine

Building a CNC Machine

Safety

Your CNC will move on its own and try to kill you.

Safety

- NOT A JOKE. WE ARE TALKING ABOUT VERY DANGEROUS MACHINES. Wear ear and eye protection

- You need to think about escape routes, Emergency Stop, Limit Switches, How you will call 911.

- Test cuts in the air with the spindle OFF.

- MAKE A CHECK LIST AND FOLLOW IT BEFORE YOU HIT GO.

- Don't leave it alone. You will be tempted to…

Why use a CNC?

- Very similar to the transition between using a typewriter and a computer.

- Accurate

- Repeatable

- Fast

- It can work while you do other things.

- You can try something, tweak it, and cut it again. Like reprinting a single page of a document.

- Can work with larger bits

- Can work with extremely small bits

- Convenient when you have multiple items to make

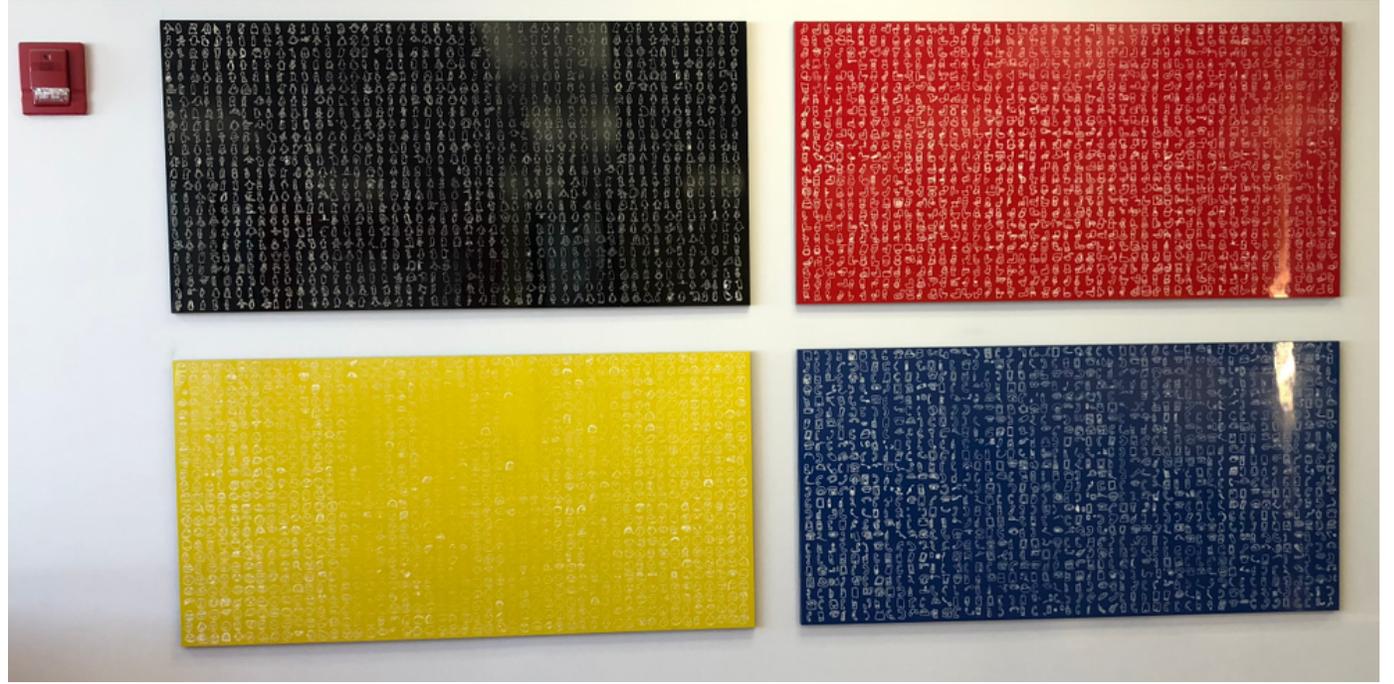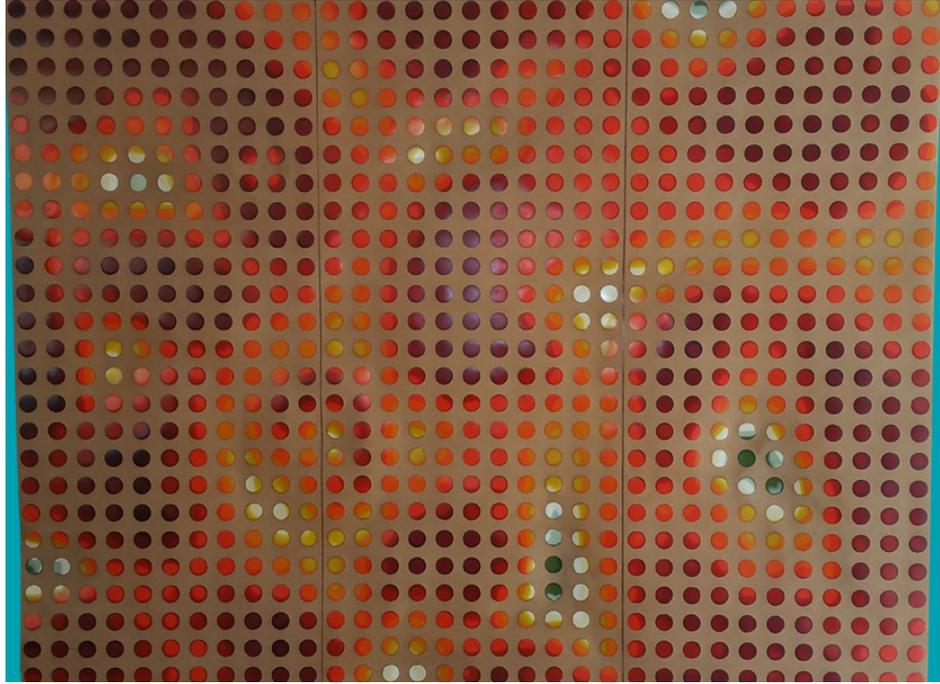- But, it has its place. Often still use a table saw, chop saw, planer, etc.
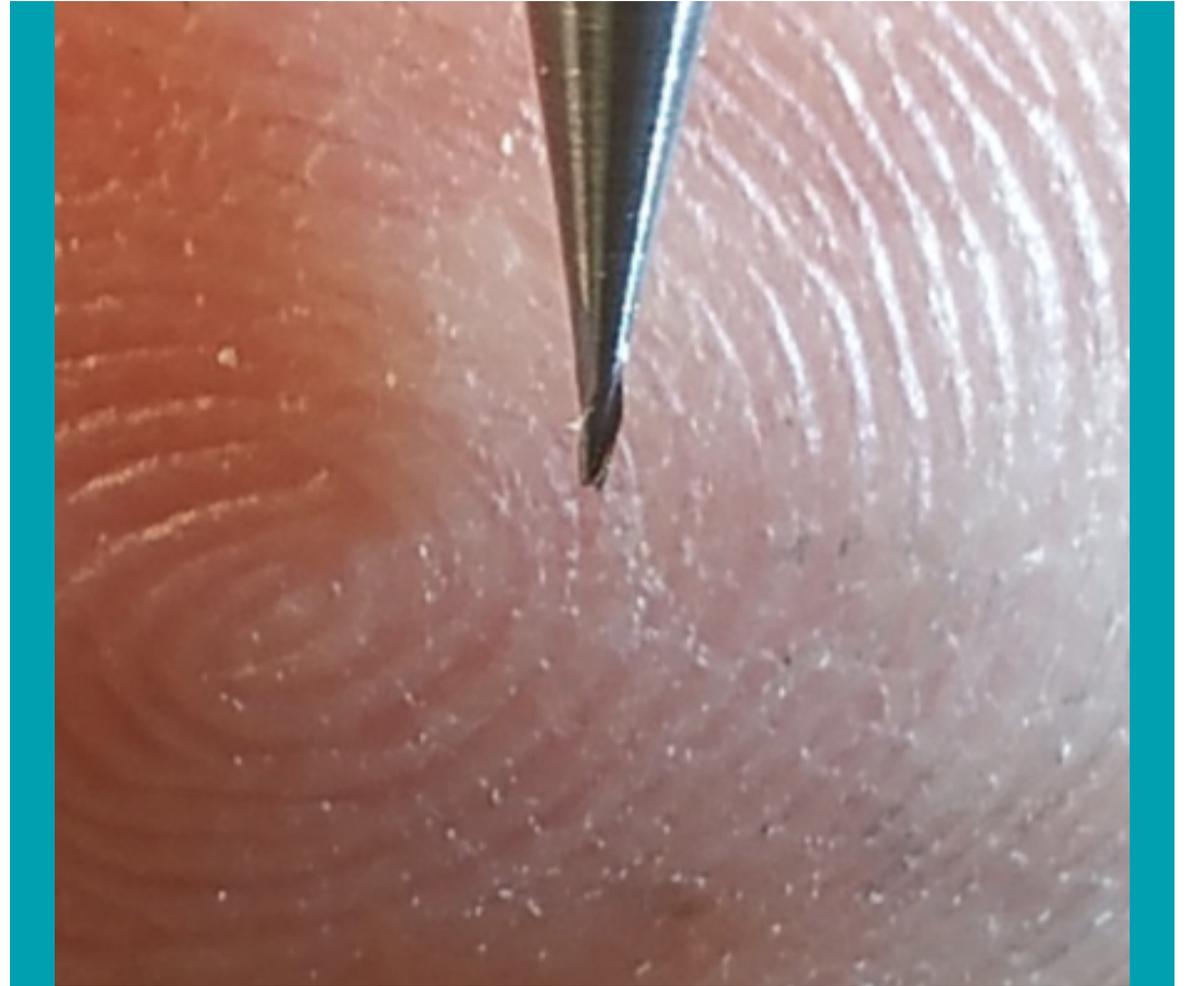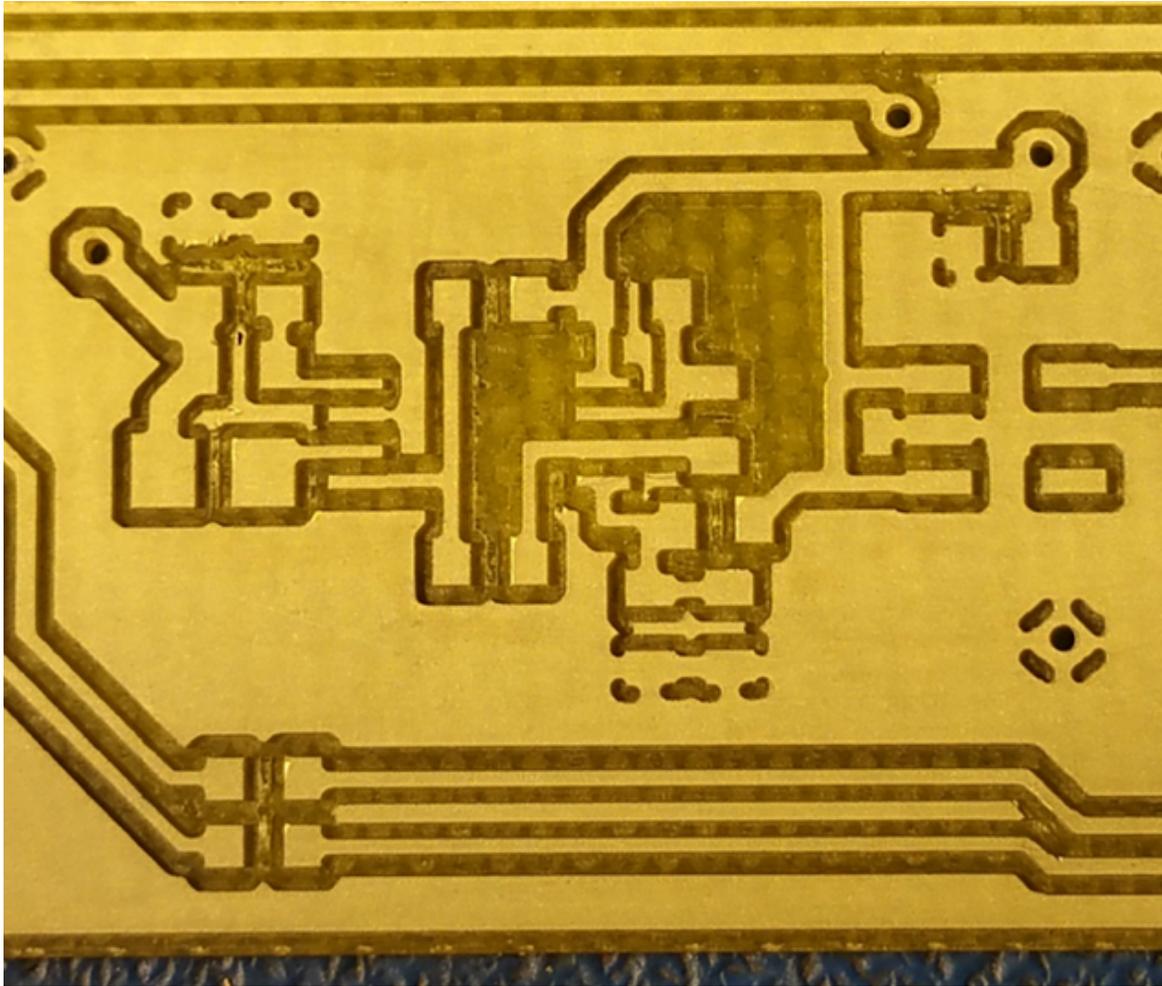
# Furniture

ART

PCBs

Components of a Design

Pens, Jewelry

Build vs Buy

- **Lots of options. More coming every week.**

- **Small light machines:**
  - ShapeOKO (Carbide3d.com
  - X-Carve (Inventables.com)
  - Search: 3018 Desktop CNC

- **Heavier Machines:**
  - CNCRouterParts.com,
  - tormach.com,
  - many others.

- **EBay, banggood.com**
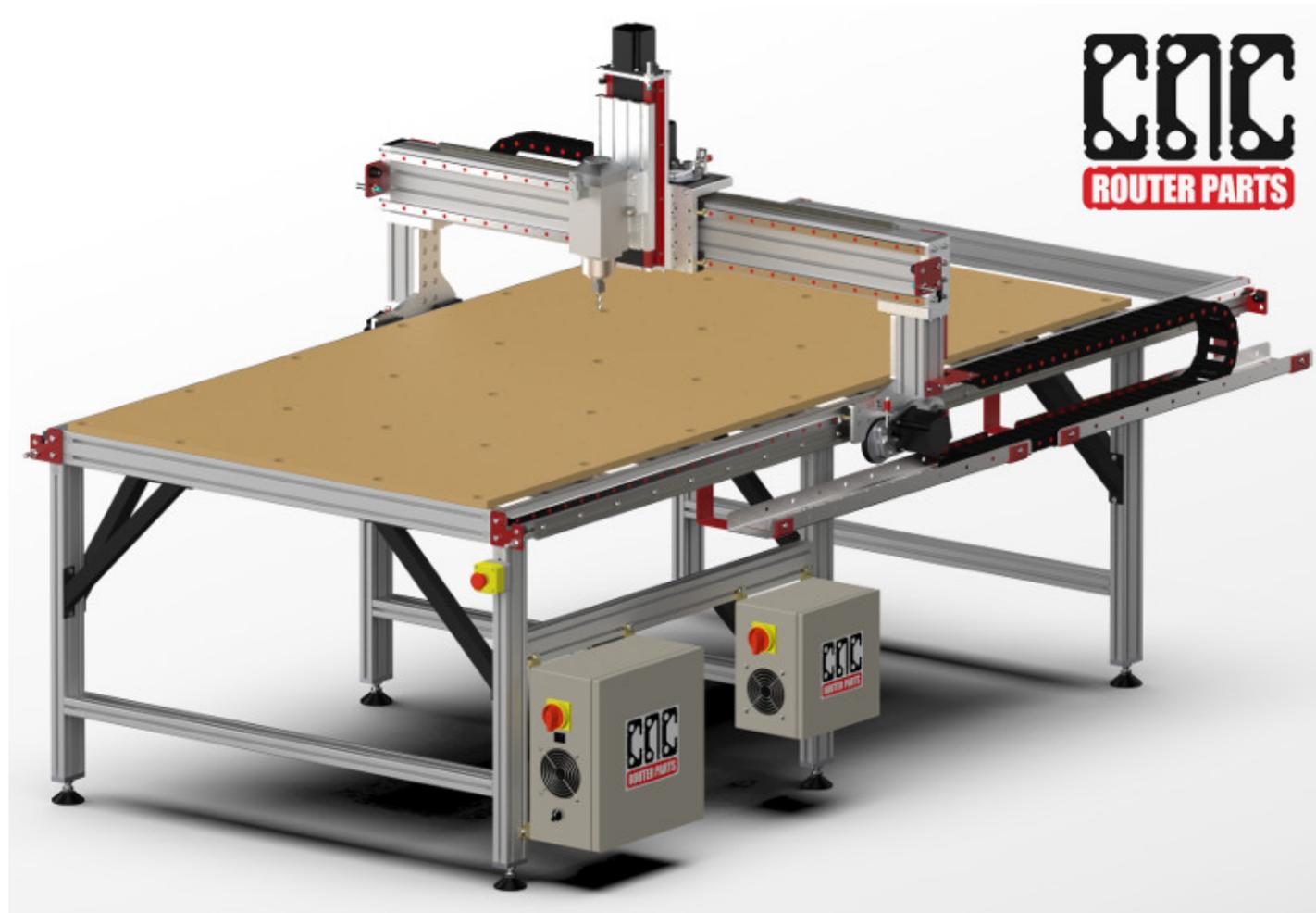
- **Auction web sites.**

  Often inexpensive big machines BUT, may need 3 phase power, etc. Can be complicated to program, calibrate, etc.

- **Convert an existing machine**
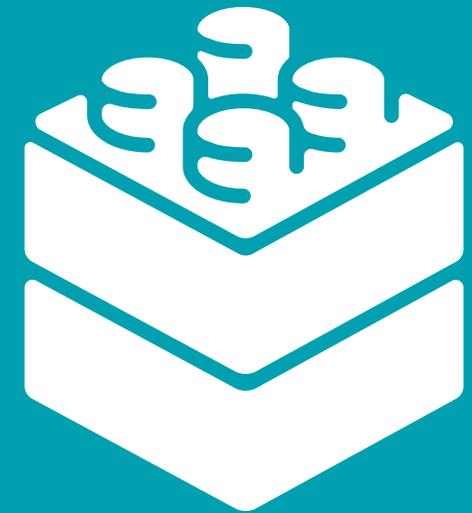
Hardware

Rigidity is KEY

Aluminum frame. 8020 framework.
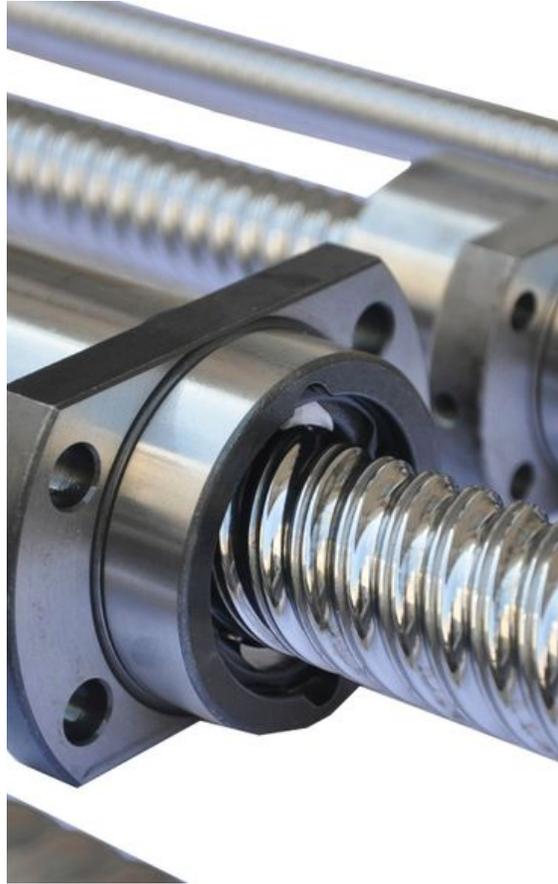
Linear Movement

Rails

Bearings

MakerSlide

Angle Iron

Making Things Move

Consider Backlash
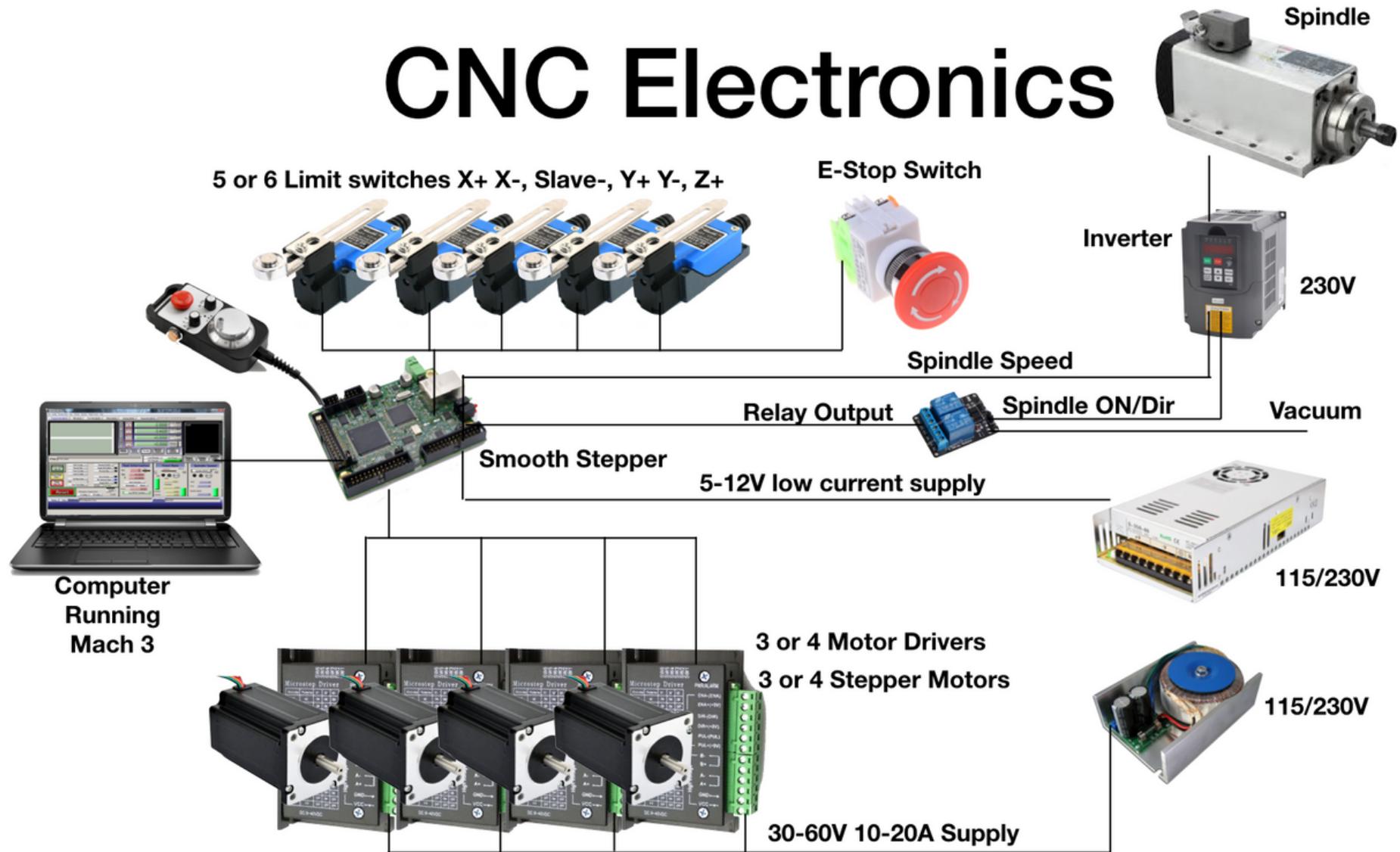
Acme Thread

Ball Screws

Belt and Pulley

Rack and Pinion

Electronics

CNC Electronics

Spindle

5 or 6 Limit switches X+ X-, Slave-, Y+ Y-, Z+

E-Stop Switch

Inverter

230V

Spindle Speed

Relay Output

Spindle ON/Dir

Vacuum

Smooth Stepper

5-12V low current supply

115/230V

Computer Running Mach 3

3 or 4 Motor Drivers

3 or 4 Stepper Motors

115/230V

30-60V 10-20A Supply
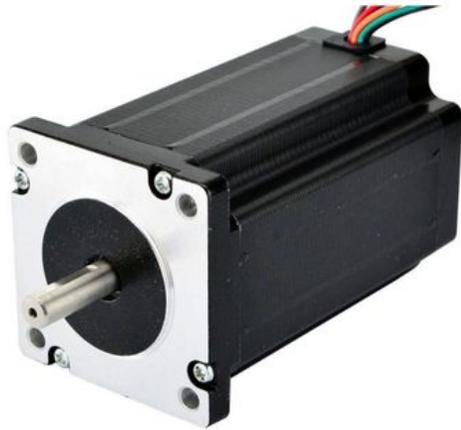
Stepper Motors

TB6600 5A Driver

- Nema 17, Nema 23, Nema 34

- Ratings: Oz-Inch 100, 300, 500, 1000!

- Power supply - 24-48V 10-30A

- Stepper motor drivers

- Step and direction

- Use latching connectors and 18/4 stranded wire for Nema 23

Control Hardware

- Smooth stepper - Connects to PC via USB or Ethernet

- Planet CNC or similar control computer

- Arduino-based controller. GRBL Some have built-in motor drivers, wifi, ethernet, usb, etc.

Control PC
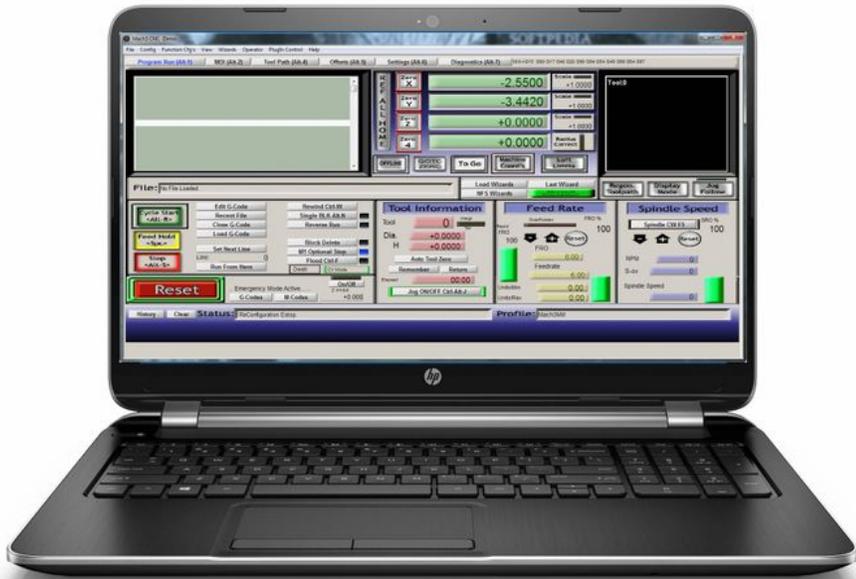
- **Parallel Port vs USB vs Ethernet**

- **Use an older version of Windows – Windows 7 - though Win7 obsolete soon.**

- **Get all s/w off the PC**

- **Turn off auto-everything and every background task.**

Miscellaneous stuff

Relay outputs - 2 is good for controlling other equipment, spindle motors, lasers, etc. Easy to control from G-Code

Limit switches - mechanical vs hall effect.

E-Stop is essential. It will save you, your workpiece or your bit one day.

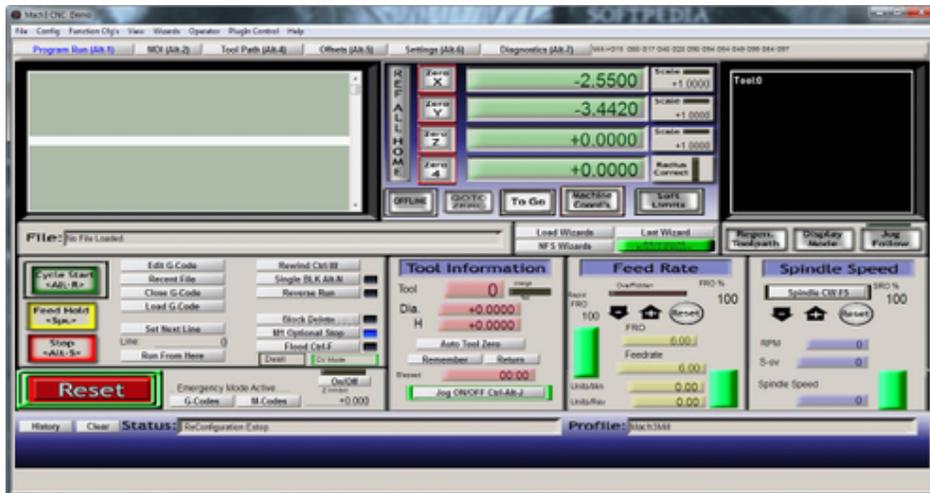Power supply - Switching vs Analog. Use latching connectors. Don't skimp

Spindle

- **Simple: Use a small Dewalt Router or Bosch Colt. Mounts available.**

- **Air/water cooled spindle - many available on eBay. Think about collet size. Order spare collets. Don't skimp. ER11 collets ok for 1/4" bits. ER20 good for 1/2" bit. ER32 good for a mill.**

- **3 Phase Inverter Hitachi vs others - lots of instructions on setting these up. Need to set about 5-10 parameters - but set as few as possible! Speed control via computer - Can be done through a digital or analog connection.**
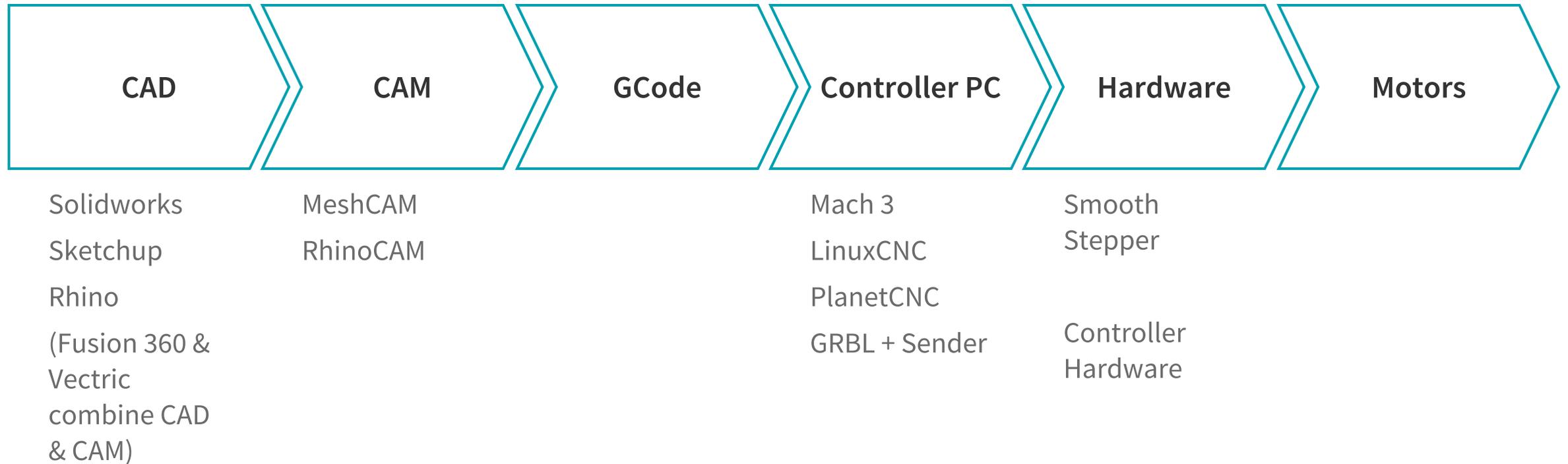
Software

Control Software

- Mach3

- Mach4

- LinuxCNC

- PlanetCNC

- GRBL Sender

Flow of operations

CAD	CAM	GCode	Controller PC	Hardware	Motors

Solidworks

Sketchup

Rhino

(Fusion 360 & Vectric combine CAD & CAM)

MeshCAM

RhinoCAM

Mach 3

LinuxCNC

PlanetCNC

GRBL + Sender

Smooth Stepper

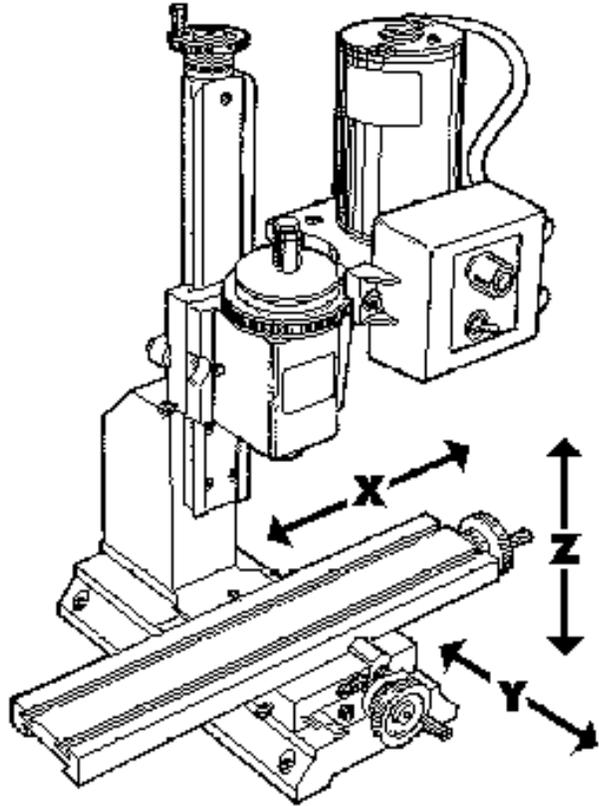Controller Hardware

CAD - Design Software

Good idea to learn more than one.

- Solidworks

- Fusion 360

- Sketchup

- Rhino3D

- TinkerCAD.com

- Vectric V-Carve Pro

- OnShape.com

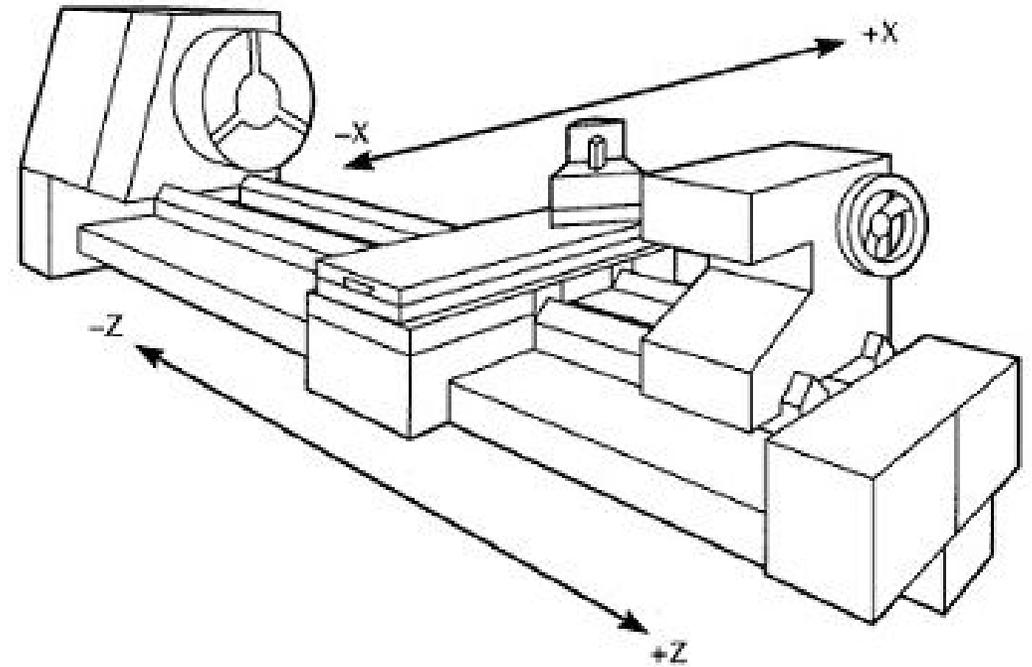- librecad.com

- vectary.com

- OpenSCAD
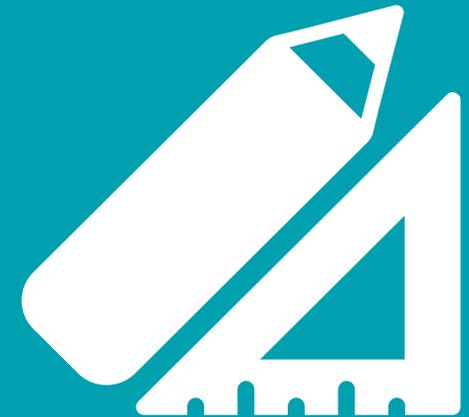
CNC Lathes

Machine Axis

Mill

Lathe

How to Make Round Things

# Extra Stuff

What Goes Wrong?

- Parts come loose. Fly across the room or jam up the cutter - break the bit.

- Forget to power on the inverter or similar.

- Wrong speed of cut

- Forget to follow checklist. (MAKE A CHECKLIST!)

- Stepper misses steps. Can be mechanical issue or electrical (bad connector or noise)

- Something comes loose. Locktite!

- Mechanical Failure - motor couplers

- Don't stand in the path of cutters/parts that might fly

Resources

- **https://loen.design (lists of suppliers & software)**

- **Vectric.com forums (fantastic resource)**

- **CNCCookbook.com (excellent blog of all things CNC)**

- **YouTube**
  - Frank Howarth - makes good use of a CNC as just another tool in the shop
  - This Old Tony - excellent CNC resources
  - NYC CNC - Lots of Fusion 360 examples
  - Lars Christensen - Fusion 360 expert
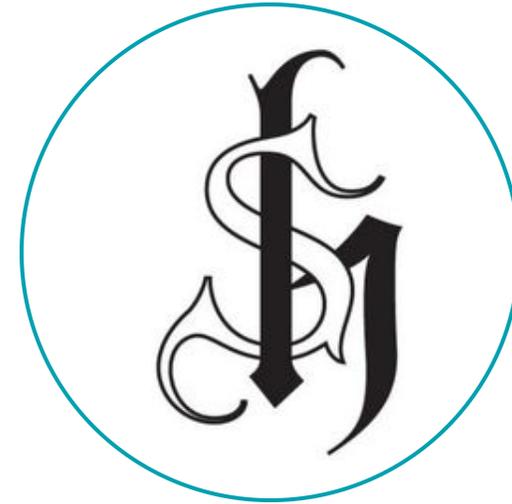 - CNCNutz - very good explanations of CNC details

Thanks!
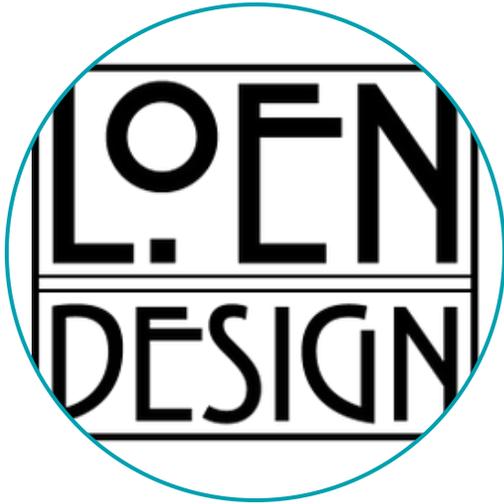
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