

# How CNC machines work

*CNC is short for...*

Computer Numerical Controlled

Other machines that use this concept include:

CNC Routers



Vinyl Cutters



3D printers



Laser Cutters and Engravers



# WHY SHOULD YOU USE A CNC (ROUTER) ?

## Pros

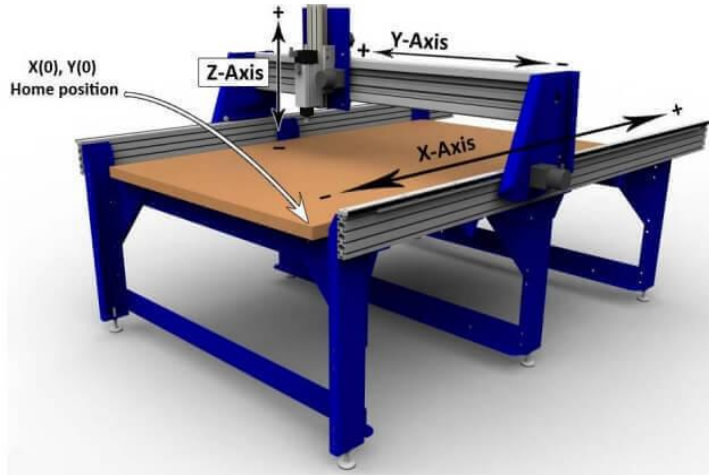
- High precision
- Generally faster than manual work
- Easy to learn
- Fantastic for prototyping
- Easy to share and reproduce your designs

## Cons

- Not meant for production
- Some jobs are still slow (as with 3D printers)
- Machine have different features, and you need to know the machine's capabilities
  
- And, of course, they are not a magic wand, capable of doing *everything* for you

# HOW CNCs WORK...

X/Y/Z axis and directions of travel



<http://fabacademy.org/archives/2015/sa/students/pena.luis>

**CNC routers** have a number of **axis** : X, Y, Z

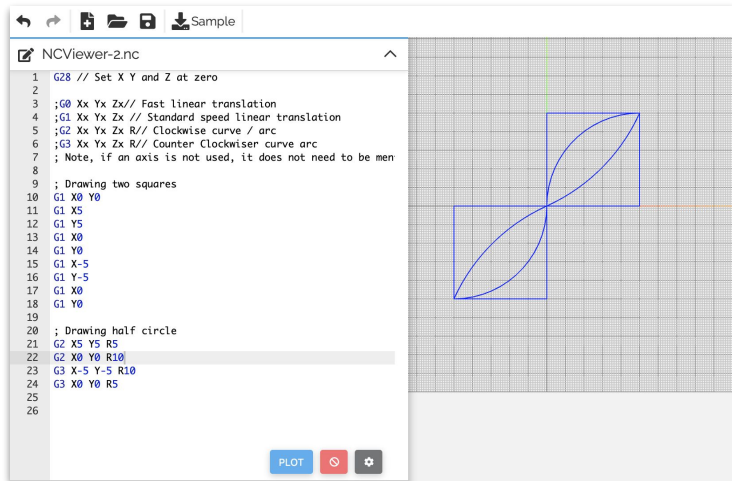
**ToolPaths** are executed by the machine to cut, carve and otherwise produce parts according to models on the computer.

Special software converts designs (2D or 3D) and generates these Toolpaths (written in **G-Code**)

For each step the machine takes, it has to know:

- Its starting point - where the machine is before the operation.
- Its end point - its coordinates in X, Y and Z from the G-code
- The type of movement (circular or linear, rapid, etc.), defined also in G-code.

# COMMUNICATING TO THE MACHINE: G-CODE



```
1 G28 // Set X Y and Z at zero
2
3 ;G0 Xx Yx Zx// Fast linear translation
4 ;G1 Xx Yx Zx // Standard speed linear translation
5 ;G2 Xx Yx Zx R// Clockwise curve / arc
6 ;G3 Xx Yx Zx R// Counter Clockwiser curve arc
7 ; Note, if an axis is not used, it does not need to be men
8
9 ; Drawing two squares
10 G1 X0 Y0
11 G1 X5
12 G1 Y5
13 G1 X0
14 G1 Y0
15 G1 X-5
16 G1 Y-5
17 G1 X0
18 G1 Y0
19
20 ; Drawing half circle
21 G2 X5 Y5 R5
22 G2 X0 Y0 R10
23 G3 X-5 Y-5 R10
24 G3 X0 Y0 R5
25
26
```

**G-code** is a language for communicating with machines - a long list of precise instructions

G-code is a rather simple language, that can be edited with a text editor like *Notepad* or *TextEdit*.

The G-code controls movement, but also parameters such as spindle speed, depending on the CNC; Or may control temperature depending on the machine. (G-code is also used for 3D Printers!)

NCViewer is a G-code simulator that is interpreting G-code for you as you edit it. Online G-code simulator :

<https://ncviewer.com>

Play around a little to understand how CNC machines “think”.

Read more in our tutorial:

<http://fablab.saul.ie/how/tutorials/learn-visualise-gcode-with-ncviewer/>

See you in the lab!

If you have any other questions try <http://fablab.saul.ie/how> - for various tutorials and other information