Digital fabrication workshop
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University of Auckland

CNC router
the basics
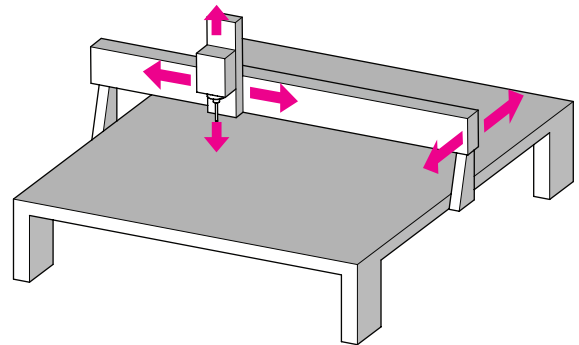

What a CNC router is
A CNC (computer Numerical Controlled) router is a computer controlled machine for cutting diffferent materials along a path, or 3D shape, generated by a software.

How it works
The spindle holds the tool and move along X,Y znd Z azis, following the paths generated by the software.
In a 3 axis router, the tool is always vertical, and undercuts are not possible.

What can be made
The CNC router can work in two different ways
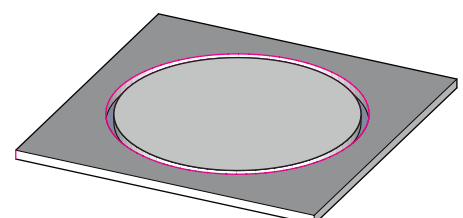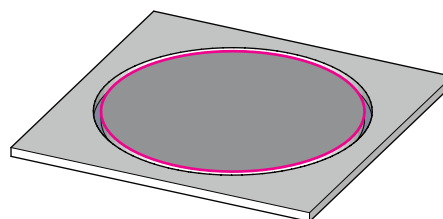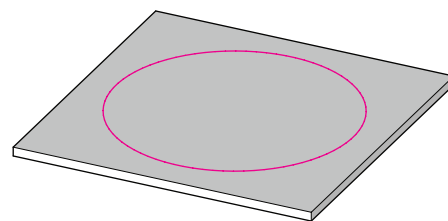-2D cutting
-3D cutting

2D cuttings
file rhino, dxf, dwg, ai, eps...
max dimension: 1200 x 2400 x 50
It cuts along a path, through the material or with a given depth (in this case the depth must be added as note to the drawing).

- profiling: the tool follows a line, on either one or other side of the line and inside or outside a continuous closed shape.
The width of the cut depends on the tool used.

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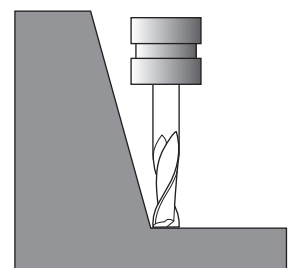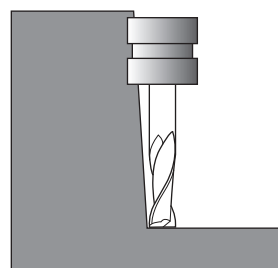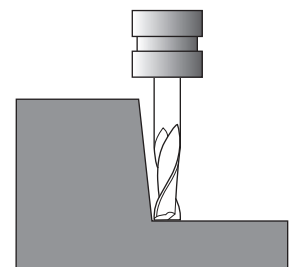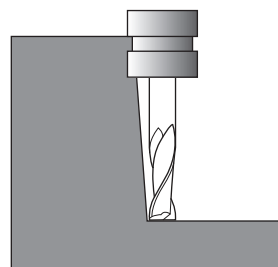School of Architecture and Planning
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Flipping the model

being the tool in a vertical position,
undercuts are not possible.

However, in some cases the model can
be flipped and machined on different
faces, provided that it has a stable face to
lay on.

In this case it is extremely important to
center the piece properly.

Limits

- the tools have a circular section, it
means that the internal corners, seen by
the top, are always rounded, only the
radius can change.
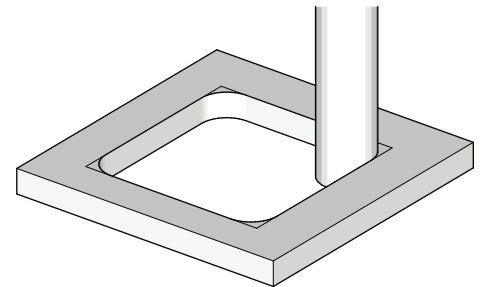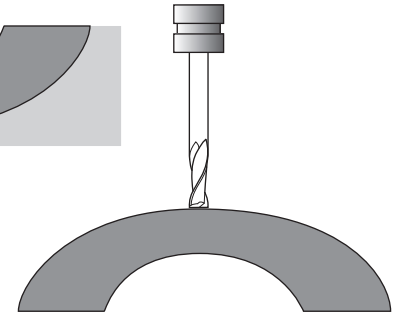- Vertical walls can only be as high as the
cutting part of the tool, not as the tool
itself.
- If the wall is steep, but not vertical, it
can be as high as the tool
- If the geometry of the model allows the
space for the spindle, the cut can be
deeper than the tool itself.

NO   **YES**

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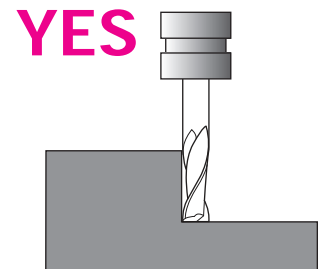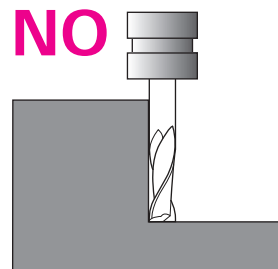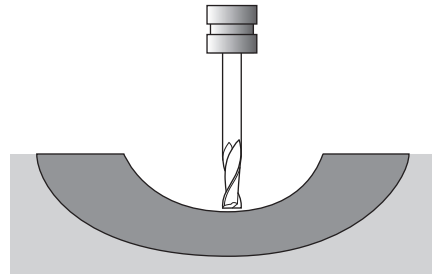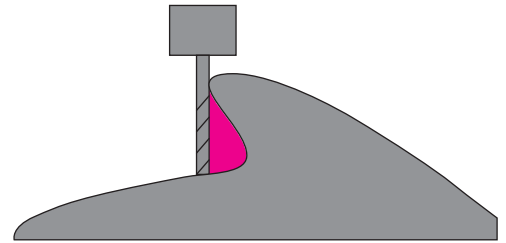
- pocketing: the tool removes all material inside an outline, to a specified depth. Pocketing tool paths only work within closed shapes, all lines must be joined without any overlaps.
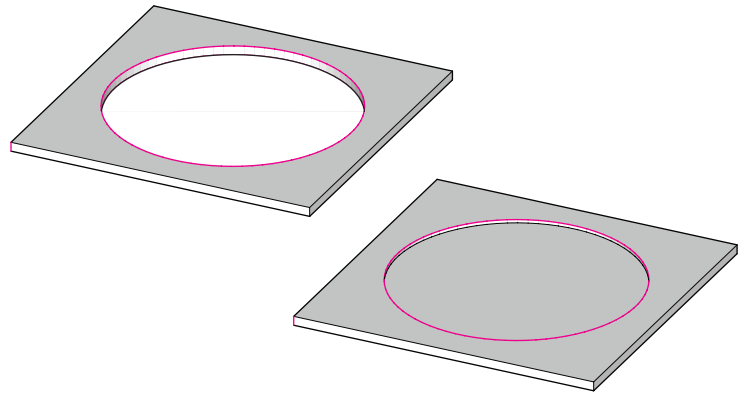
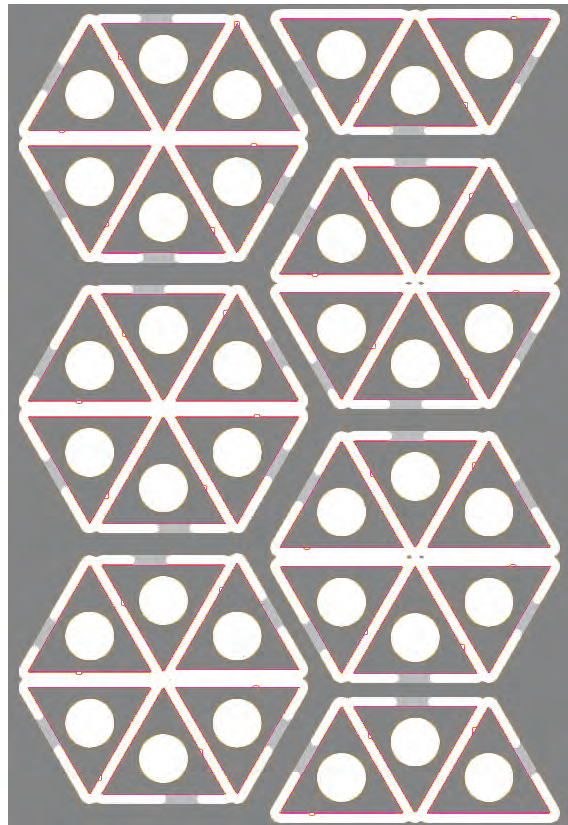When cutting more pieces in oneshhet of material, you must allow space for the tool, the thicker the material, the bigger the tool.

If the pieces are many and small, the must be arranged on the board so that all of them are connected with a solid frame, in order to leave a small part uncut, and keep them in position.

3D cuttings
file rhino, stl...
max dimension: 1200 x 2400 x 200 (in some cases the Z dimension can be up to 250, depending on the tools used).

The machine runs different cutting paths:
- roughing cut, removing successive layers of material around the model
- finishing cut, along the surface of the model
- other cutting paths can be eventually performed:
  - for refining concave edges that have been cut rounded with a rounded tool,
  - for adding an engraving on the surface of the model (a road on a site model, for example).

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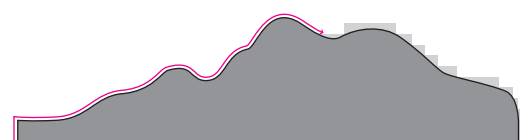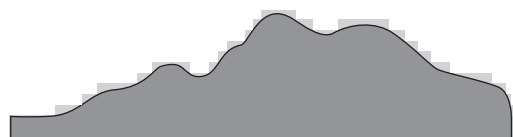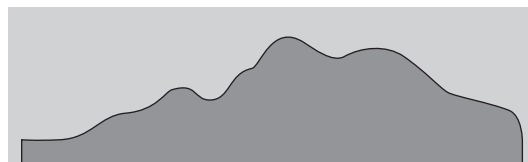
Tools

The tools used for cutting are many
different kinds.
The most commonly used are:
- endmill, with the flat edge, are mainly
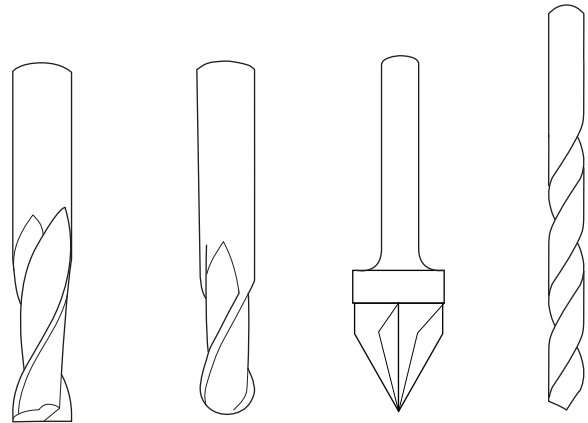used for the roughing cut, and for
refining flat orizontal surfaces and sharpe
corners;
- ballnose, with a rounded edge, mainly
used for finishing smooth surfaces;
-veemill, used for engraving and for tapering edges;
-drill bits, for making holes.

Some feature to keep in mind:
- a big tool can usually be longer then a small one;
- a big tool can cut faster than a small one;
- a big ball-nose tool can't reach small valleys, but makes a smoother finish.

Materials

In some cases, it may be useful to have some spare material for making some test before
cutting the model.
MDF is very good for 2D cutting, being very flat.
However the cut edges will have a fluffy surface finish not suitable for fine detail.
Plywood is very good for 2D cutting.
It can be used also for 3D cutting, giving an interesting stripped result.
Solid wood is very good for 3D cutting.
Wood with a fine grain, like totara, are better for fine details models
Cibatool-chemical wood is perfect for small (high cost) and high detailed 3D cutting.
Polystyrene is good for big dimension-low details model.
The blue green one gives a better surface finish, but has a maximm height of 50mm, while the
white one can be purchased in bigger dimension.
Acrylic produces a reasonable finish but still requires a lot of wet sanding and polishing to get it
clear again
Aluminium can be 3D cut or engraved, but not cut through.

Other material can be tested.

Stone, **concrete, glass** and **fiberglass** can never be cut.