FABO ACADEMY X - CHINA

SUBTRACTIVE MANUFACTURING

FABO ACADEMY X 同济大学设计创意学院 Fabo | Shanghai

CNC MILLING

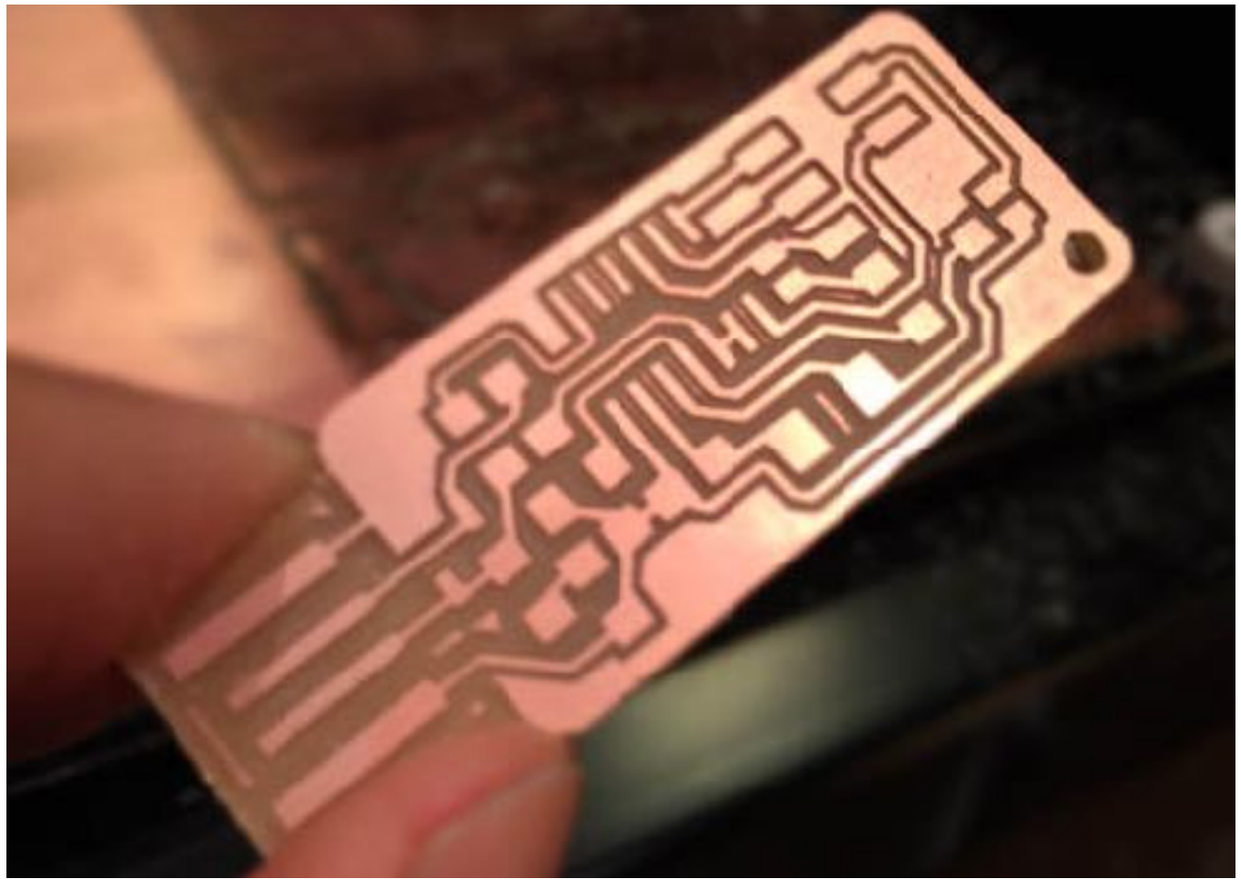
Subtractive manufacturing: removing material or milling out a shape from a “stock material”

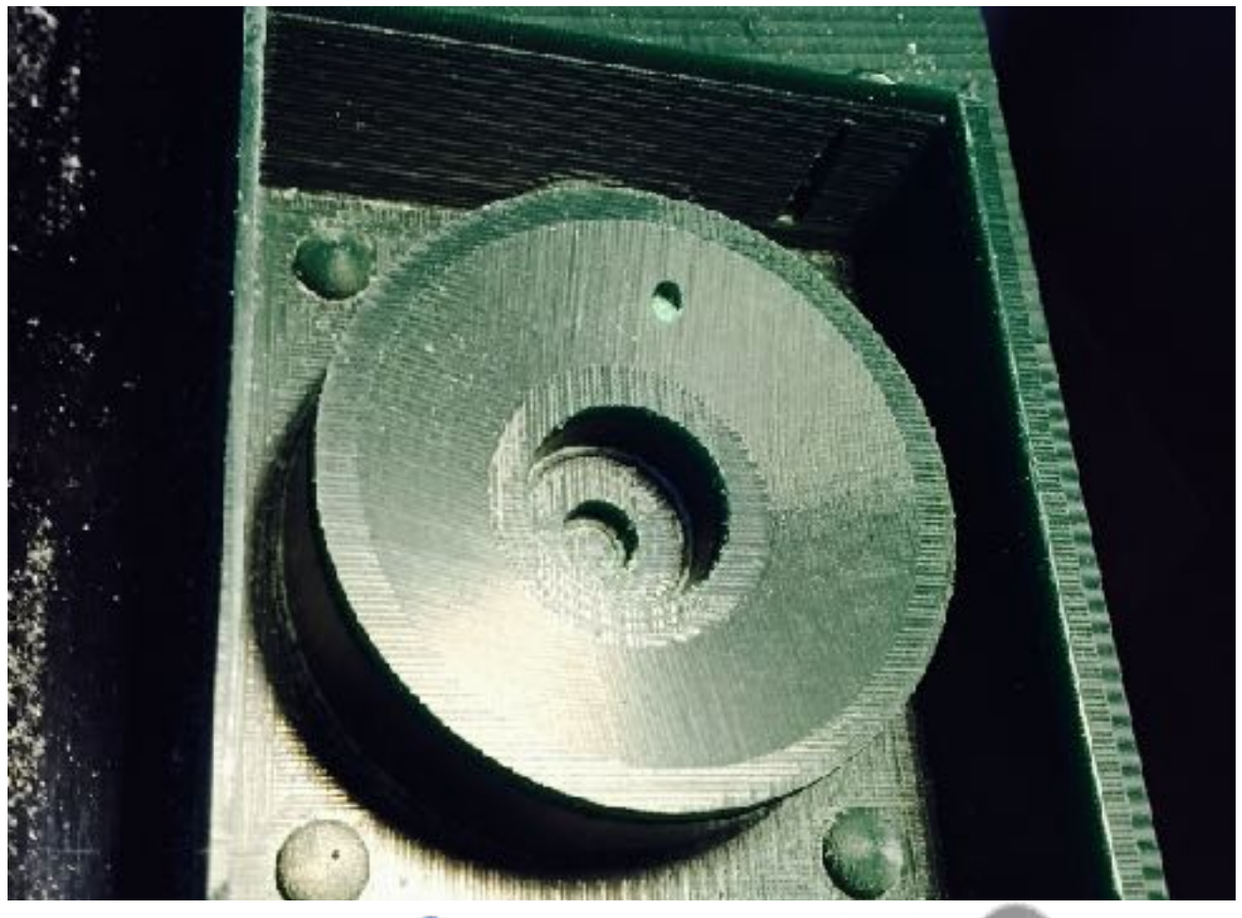
MILLING WORKFLOW

- 3D model.
- Tool path generation - Gcode or .rml (Roland format)
- Setting up the machine
- Milling

WHEN IS IT USED?

- For making molds
- Milling out the part itself
- CNC (computer controlled cutting)
- Circuit boards





STOCK MATERIALS

- Machinable Wax (reusable)
- Polystyrene Rigid Insulation Foam
- Veneer Plywood
- Medium Density Fiberboard (MDF)
- Medium Density Overlay (MDO)
- High Density Polyethilene boards (HDPE)
- Oriented Strand Board (OSB)
- Polycarbonate
- Aluminium

Machinable Wax (reusable)

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Oriented Strand Board (OSB)

Polycarbonate

Aluminium

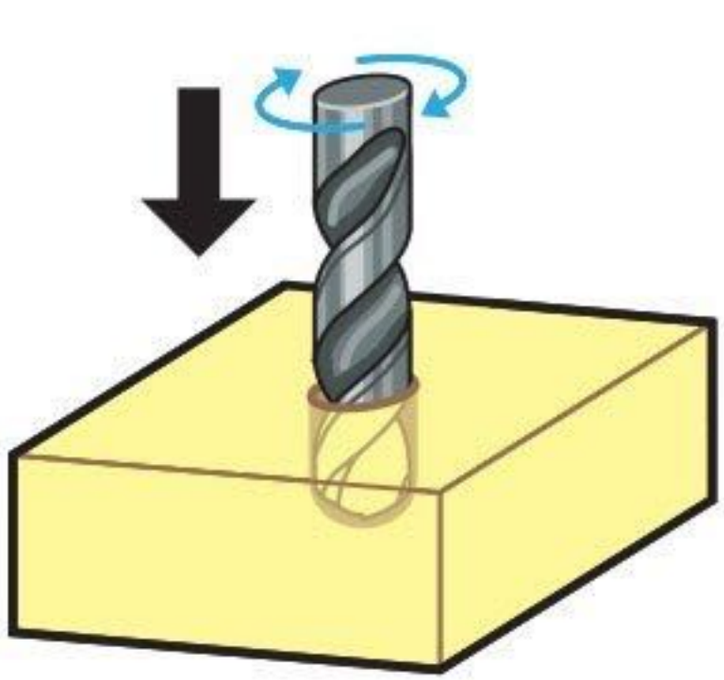
FIXTURING OF MATERIAL

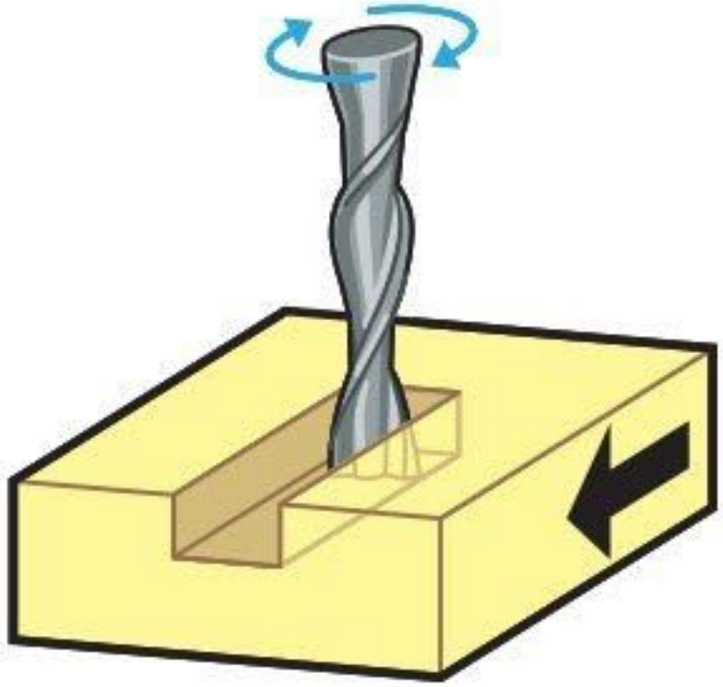
- Sacrificial layer
- Wise
- Clamps
- Vacuum
- Weights
- Glue
- Tape
- Screws

  (carefully placed so not intersecting tool path)

TOOLING

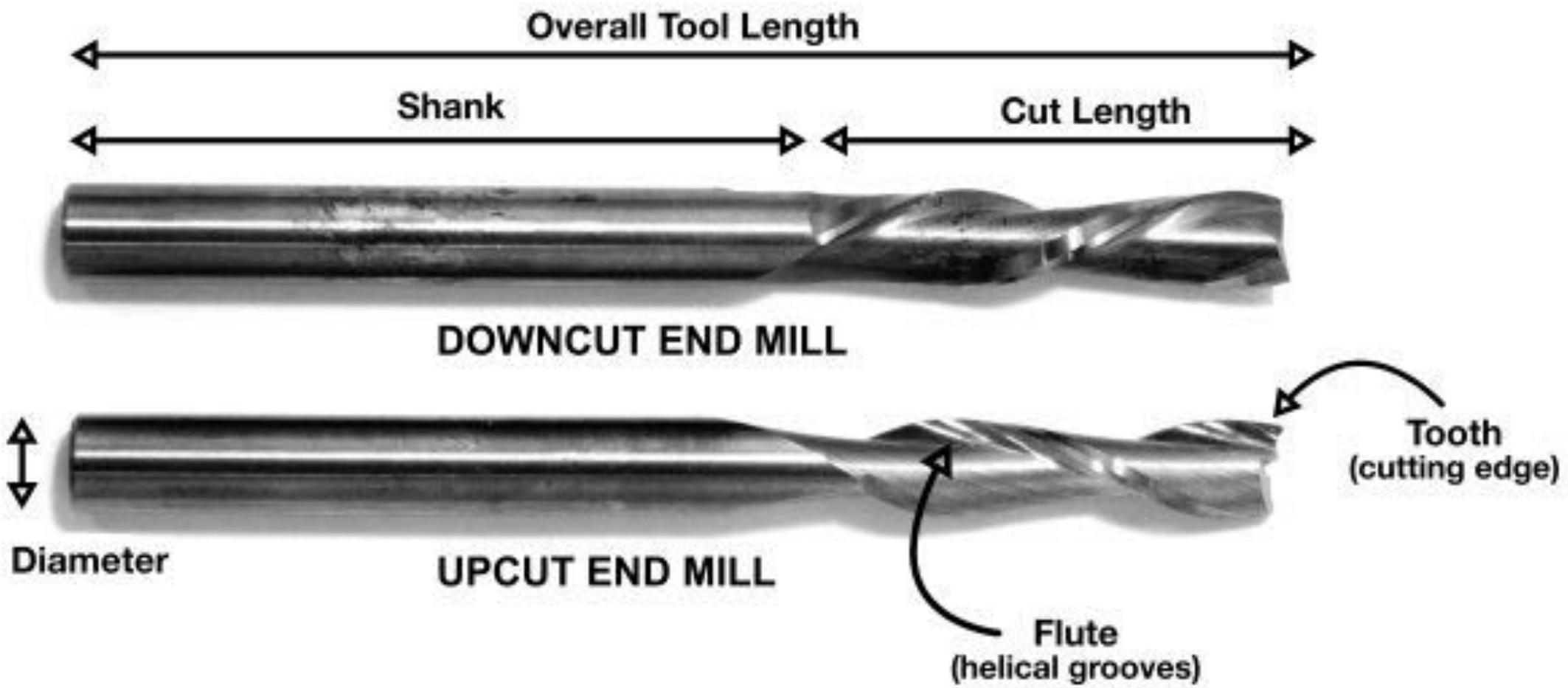
DRILL BIT VS END MILL





ANATOMY OF AN END MILL

- Shank
- Flutes
- Coatings
- Diameter
- Shank Diameter (collet)
- Up/Down Cut



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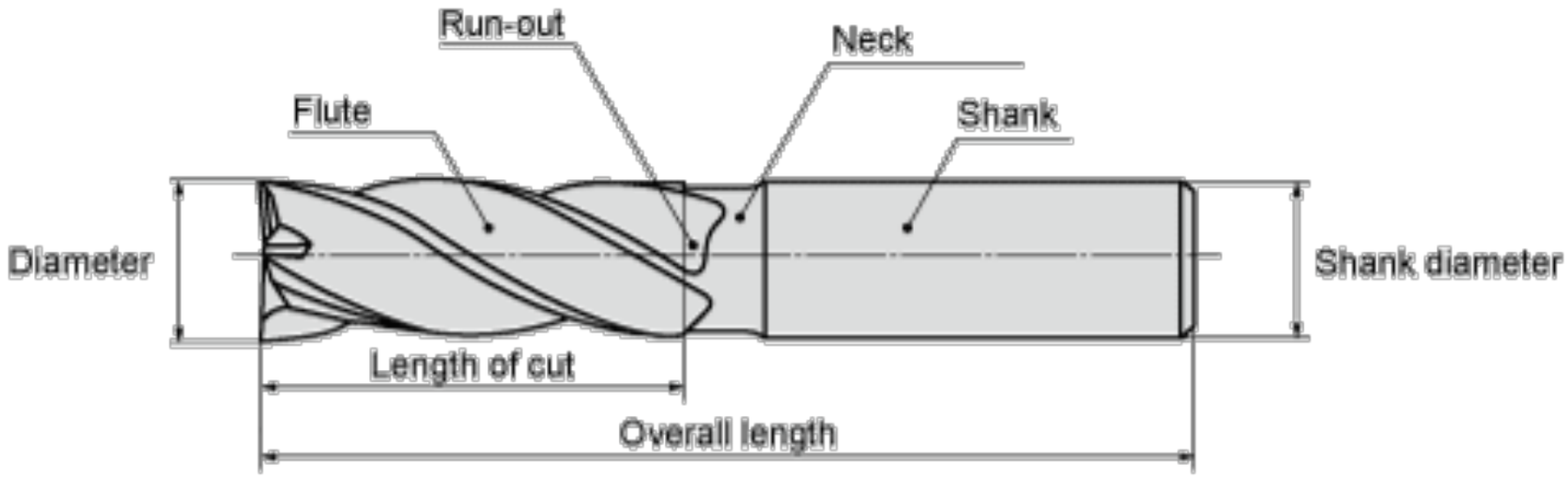
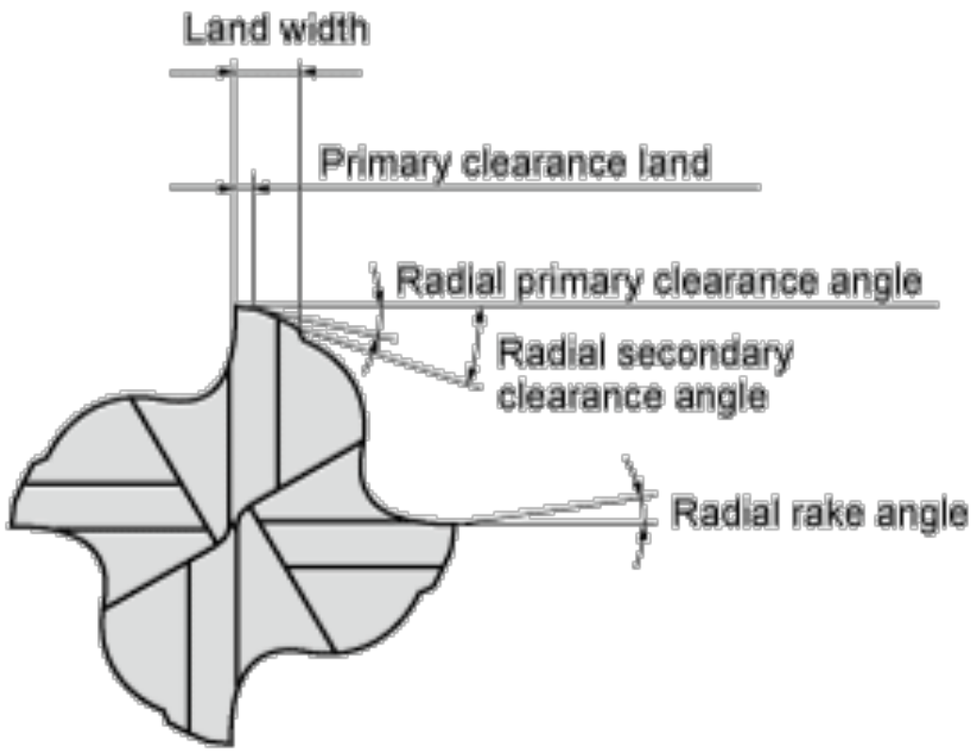
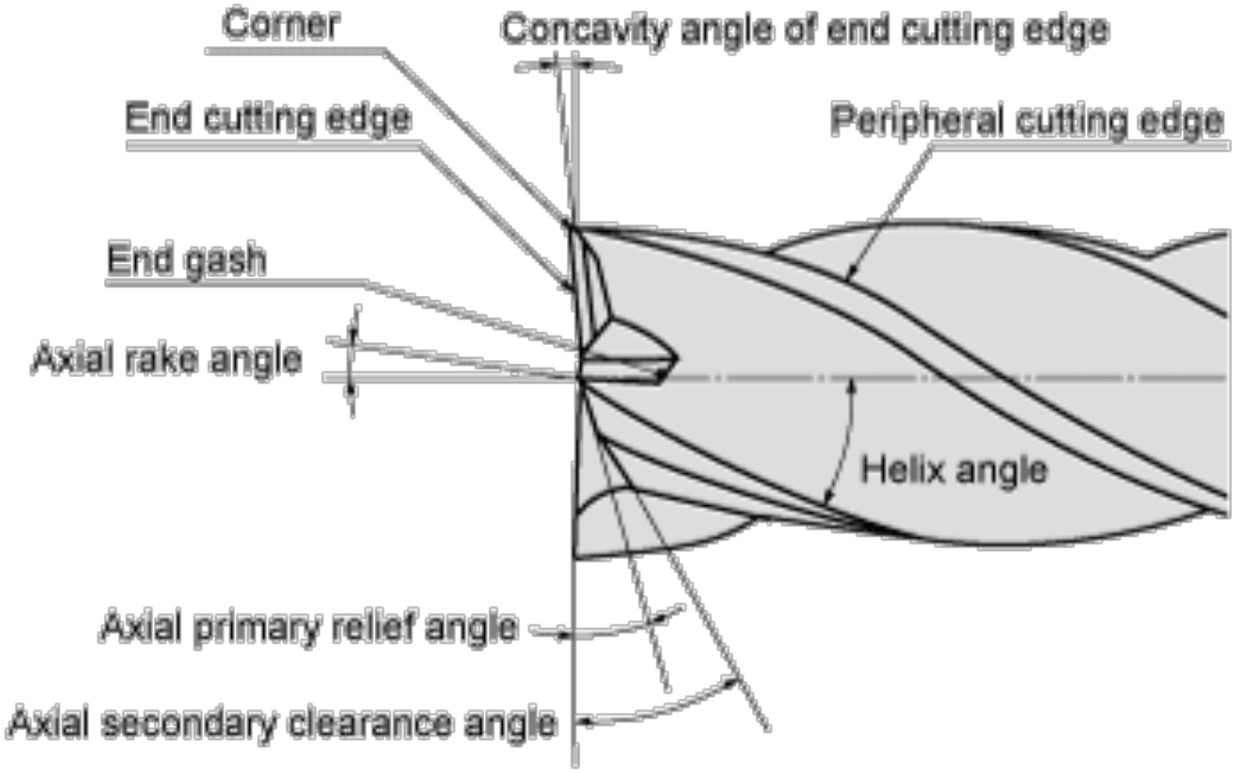
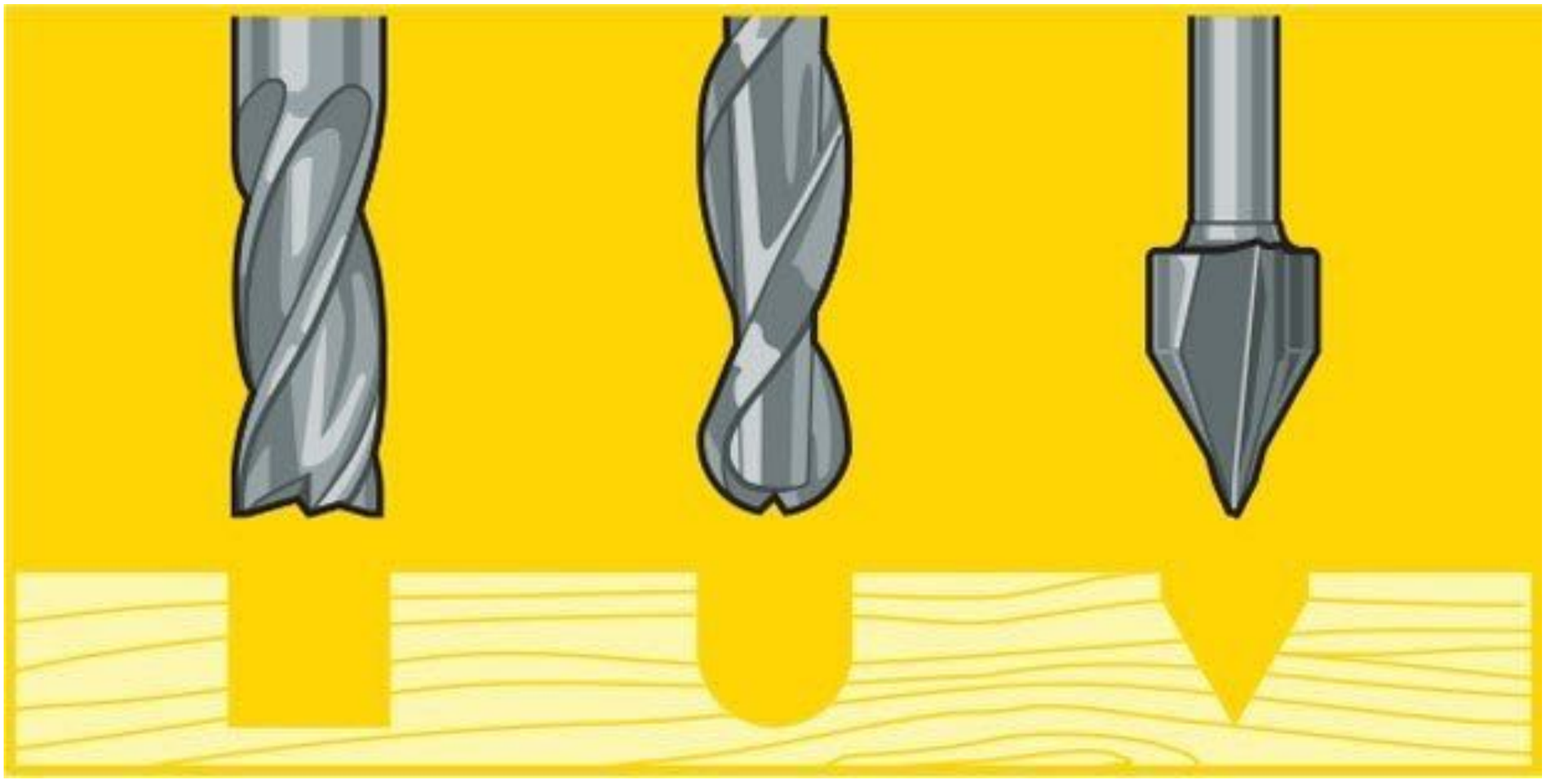






SHAPE OF AN END MILL



Flat **Ball** **V Shaped**

NUMBER OF FLUTES?

- More flutes create a smoother surface finish.
- Fewer flutes are better for chip clearing.
- One, two or four flute are most common.

GENERATING TOOLPATHS

GENERATING TOOLPATHS

- 2, 2.5, 3, 4, 5 Dimensions/Axes
- Feeds and Speeds
- Conventional vs Climb
- Cut Depth
- Step Over
- Kerf
- Clearance, collisions
- Tabs
- Test cuts, cutting air

TYPES OF TOOLPATHS

2/2.5D

Contour
A contour toolpath is used with curves and lines. It is typically used to do profile cuts from sheets of material such as ply and mdf. It is one of the most frequently used toolpaths and easiest to set up.

Pocket
A pocket toolpath uses closed curves and removes all of the material within the curves boundary. The user sets the depth.

3/4/5D

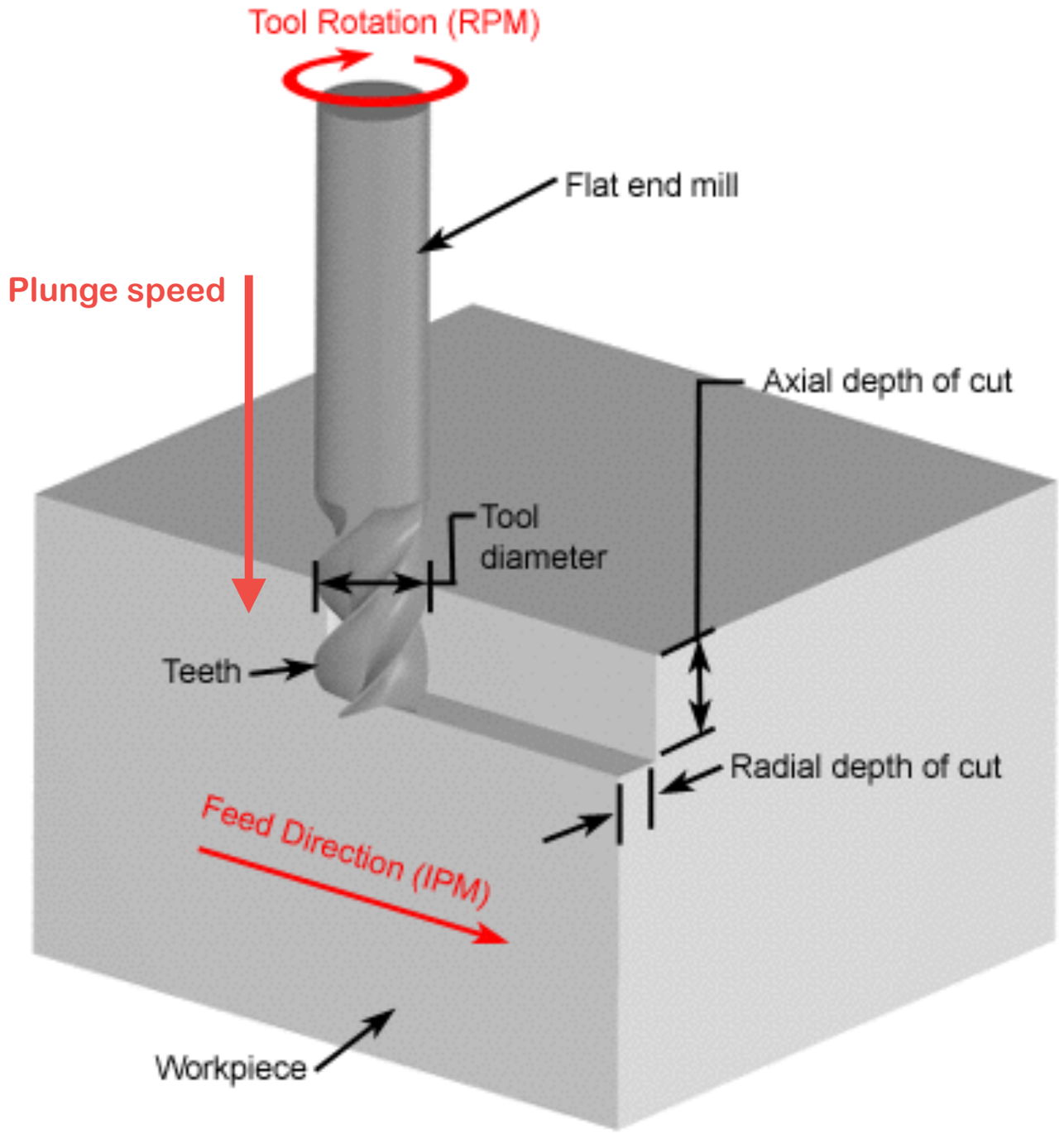
Roughing Toolpath
A Roughing Toolpath is a toolpath that removes a large amount of material quickly. It cuts at incremental depths (depth cuts) and stays offset from the finish surface.

Finish Toolpath
A finishing toolpath only routes the finish surface and does not do any depth cuts.

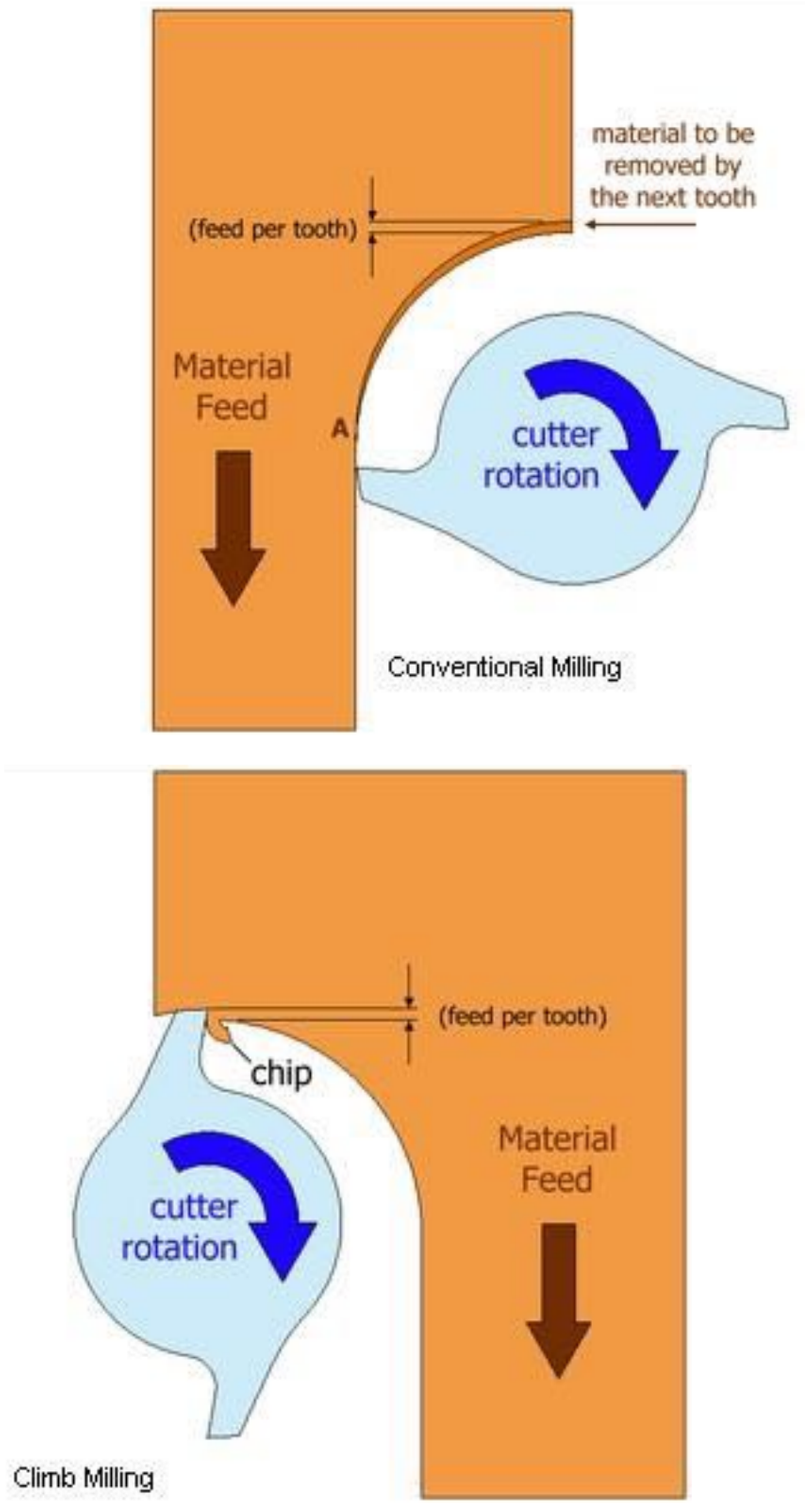
2, 2.5, 3D

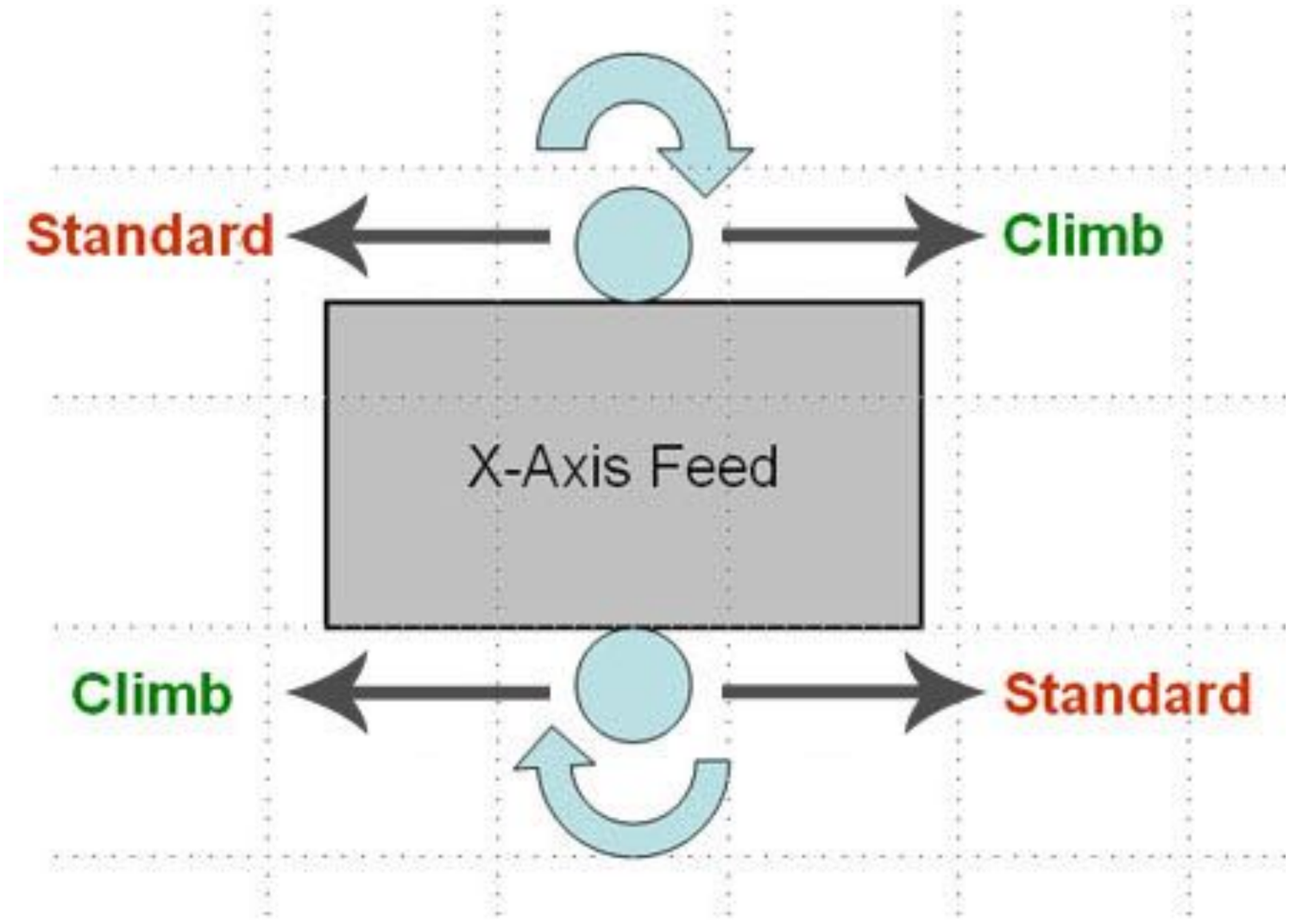
Full 3-D Design/Model (surface and relief)

FEEDS, SPEEDS

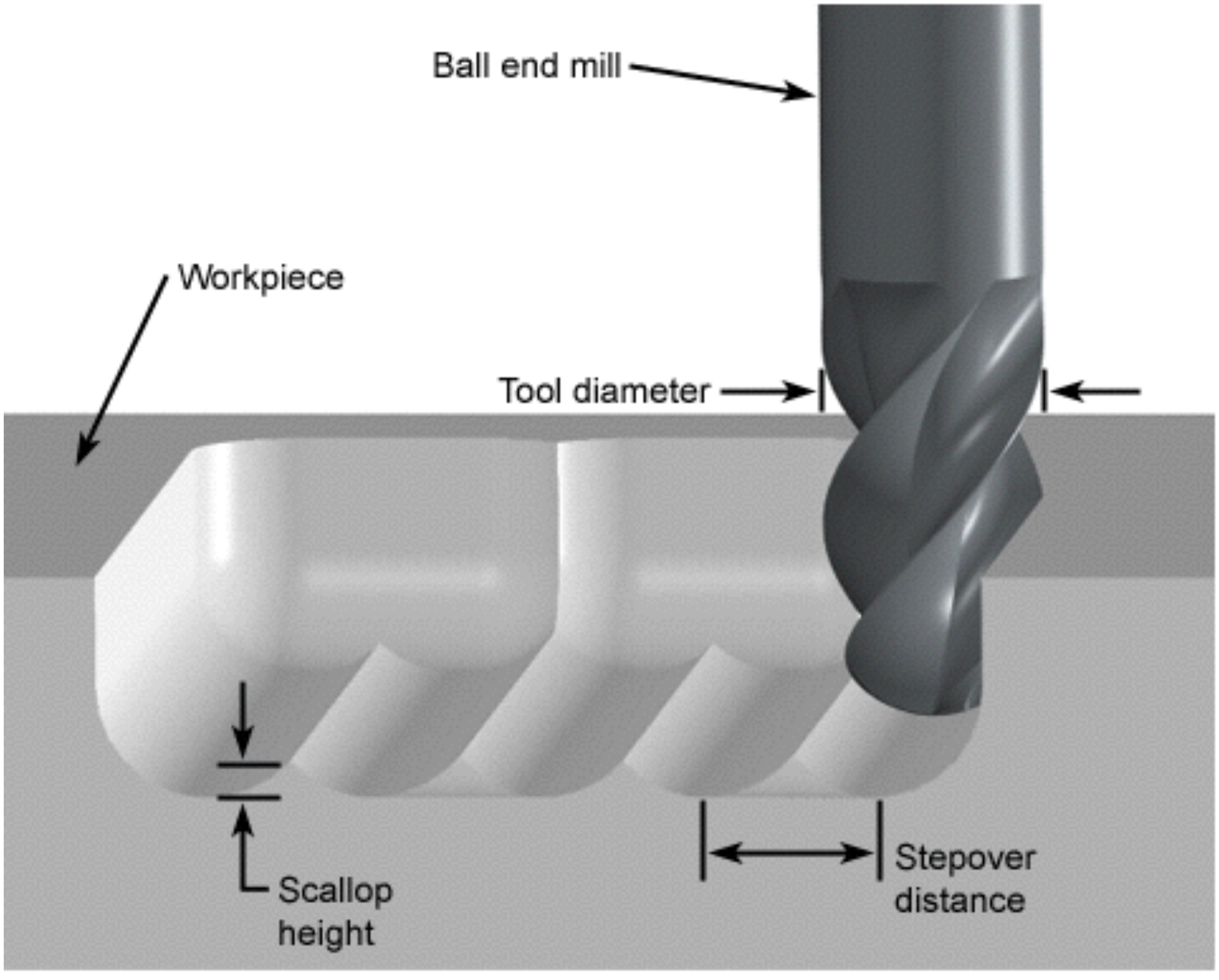


CONVENTIONAL VS CLIMB

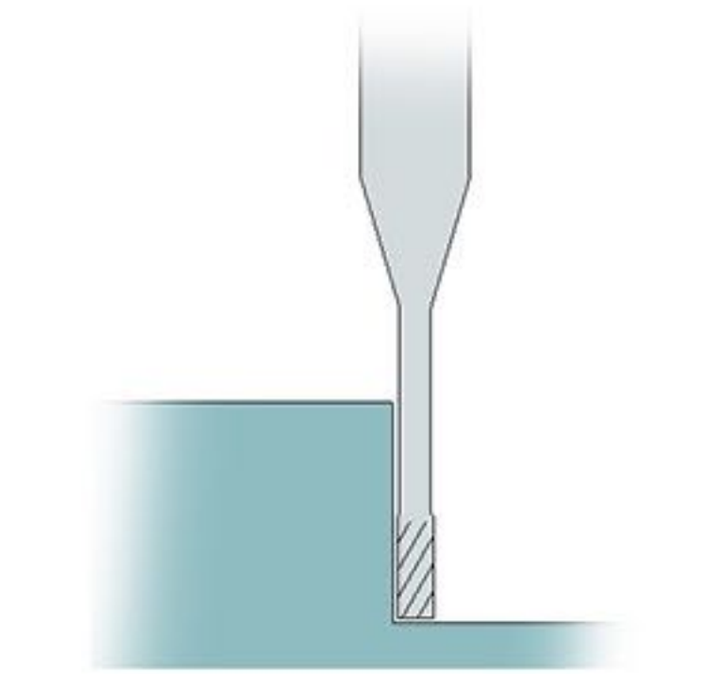


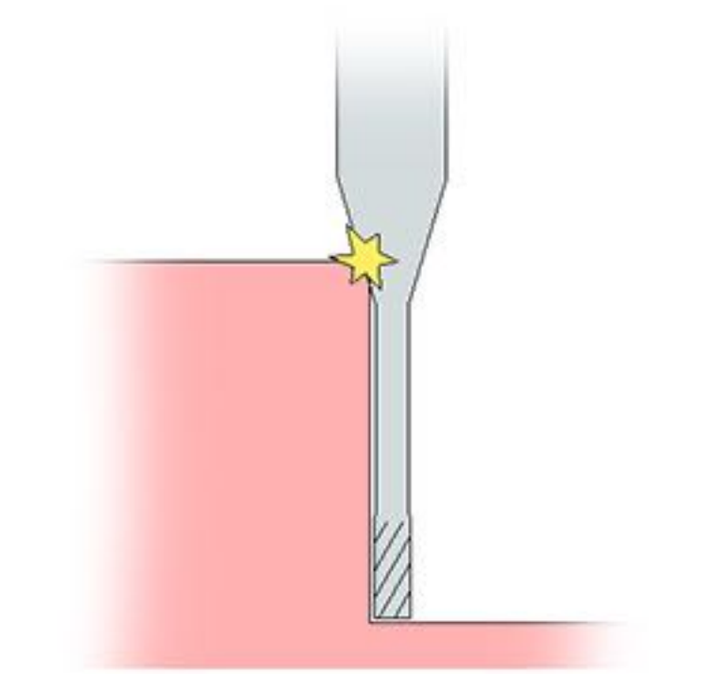


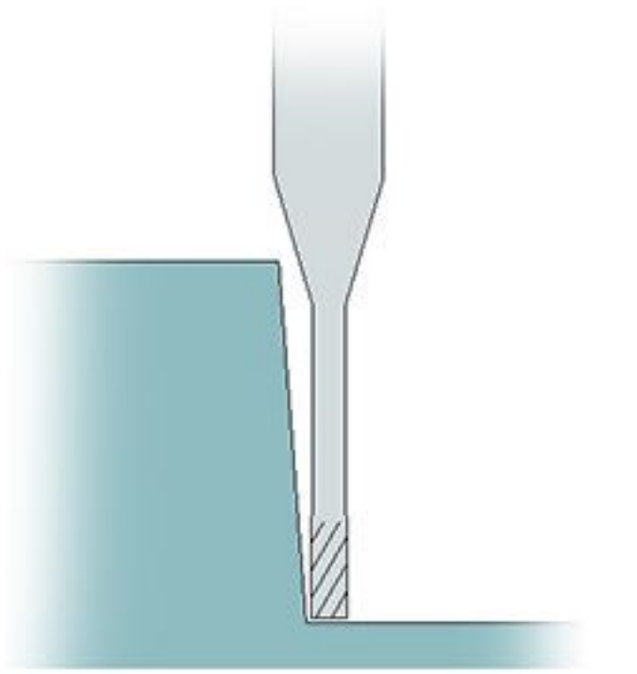
STEP OVER

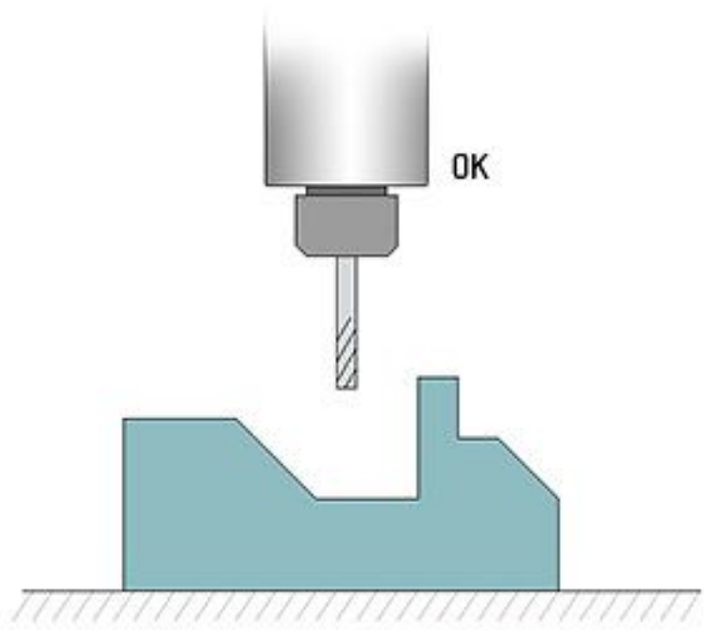

Ball end mill
Workpiece
Tool diameter
Scallop height
Stepover distance

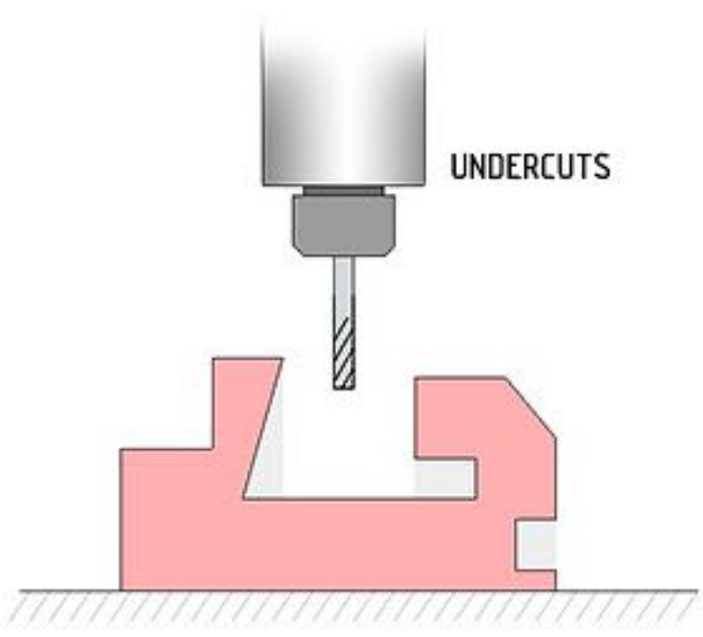
CLEARANCE, COLLISIONS

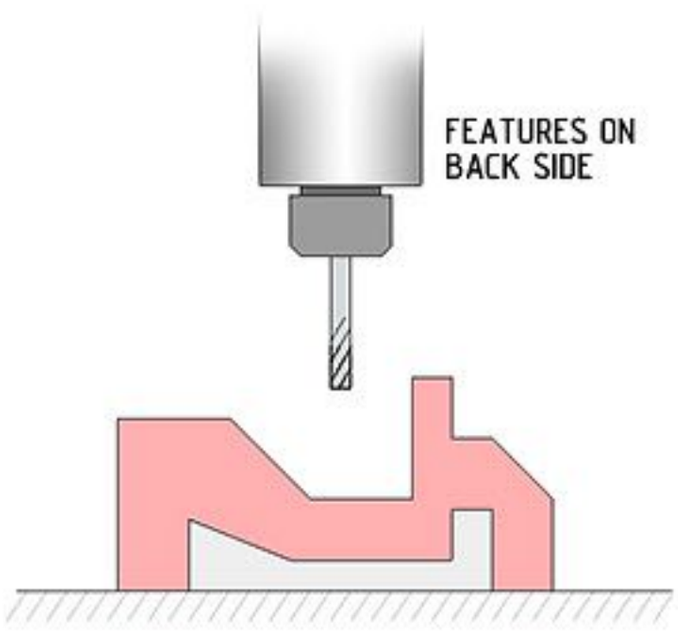




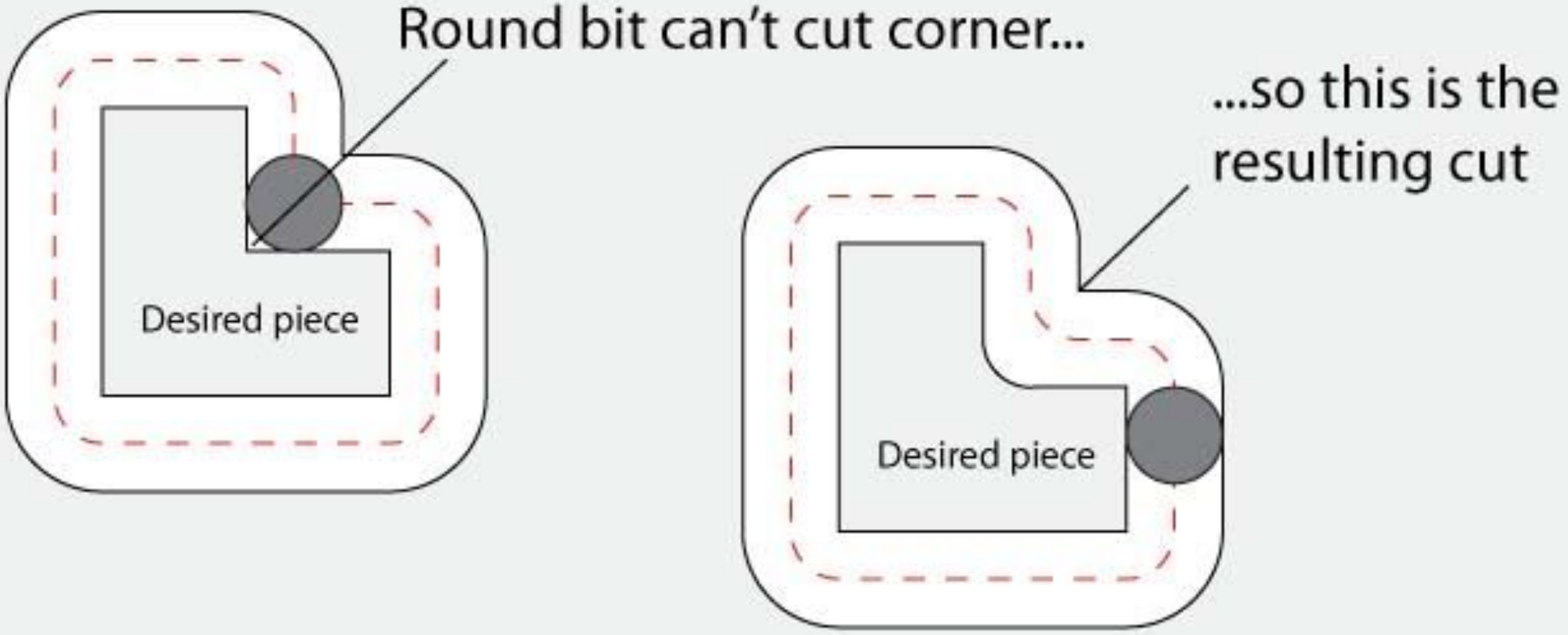








GEOMETRY LIMITATIONS



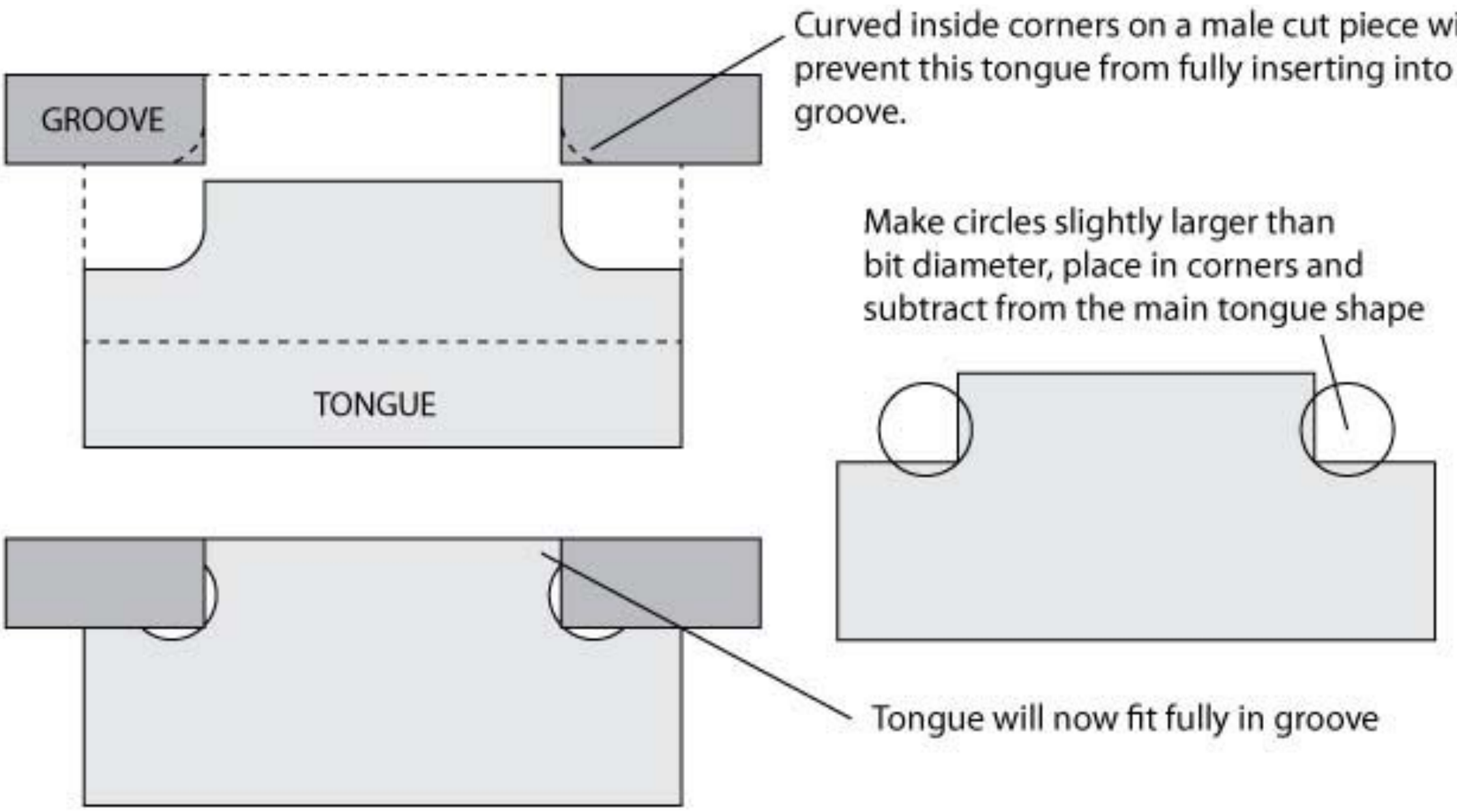
GEOMETRY LIMITATIONS

Make a circle slightly larger than bit diameter and place in all 4 corners

Combine / unit / merge / weld shapes (term varies by program)

Square end piece (tongue) can now slot intside.

GEOMETRY LIMITATIONS



SOFTWARE WORKFLOW

DESIGN (CAD 2D/3D)

- Autocad
- Rhinoceros
- Fusion 360

GENERATE AND MANAGE TOOLPATHS (CAM)

- Fab Modules
- Roland Modela Player
- V Carve (Cut 2D, Cut 3D)
- Autodesk Fusion 360
- Rhino Cam

EXERCISE

Design and mill a mold (12 x 12 x 4,5 cm) from blue foam (negative) and make a concrete cast (positive).