

# Construction of a 5-axis router demonstrator and its integration with Linuxcnc

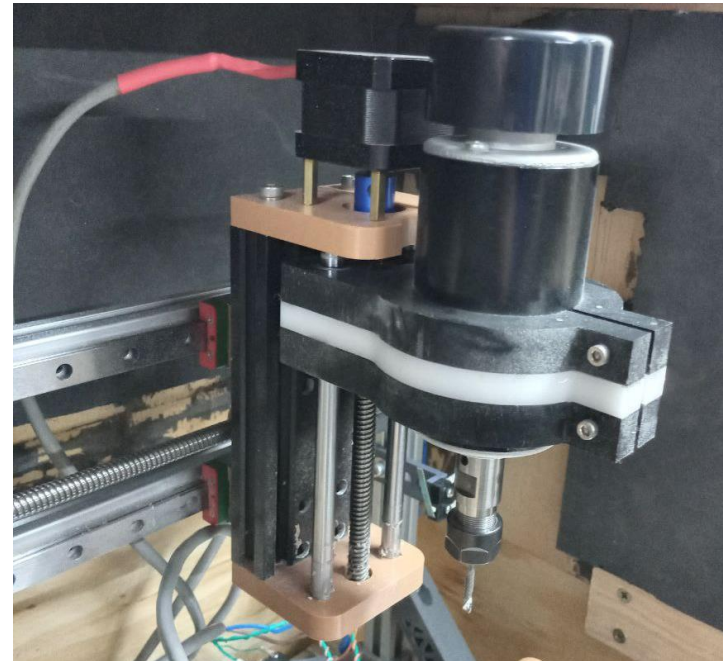
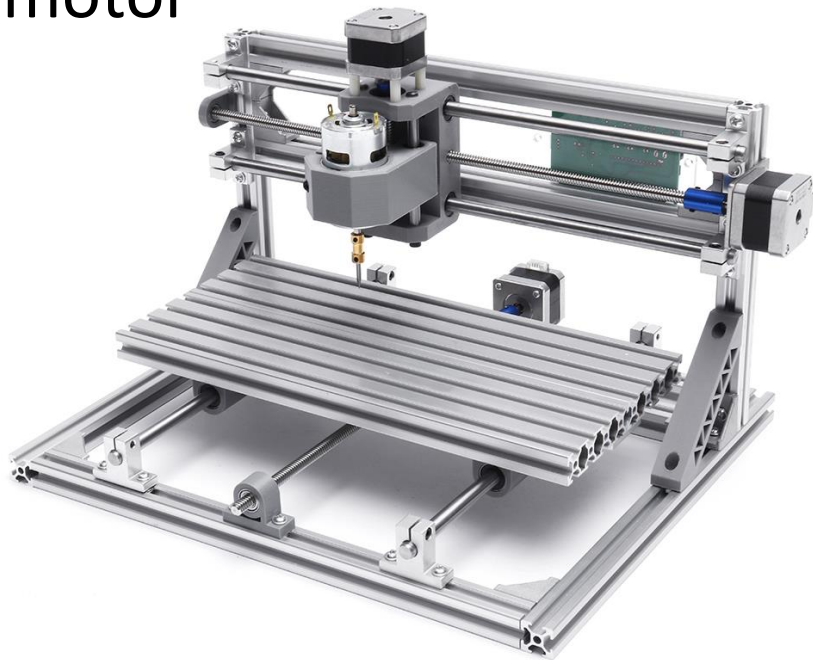
By Danie Gouws

# Aim of the Project

- Learn about what is required to set up a 5 axis cnc machine on Linuxcnc
  - Hardware
  - Electronics
  - Software
- Feasibility of using Linuxcnc vs Mach3 on future machines
- Learn about kinematics involved
  - Matrix calculations

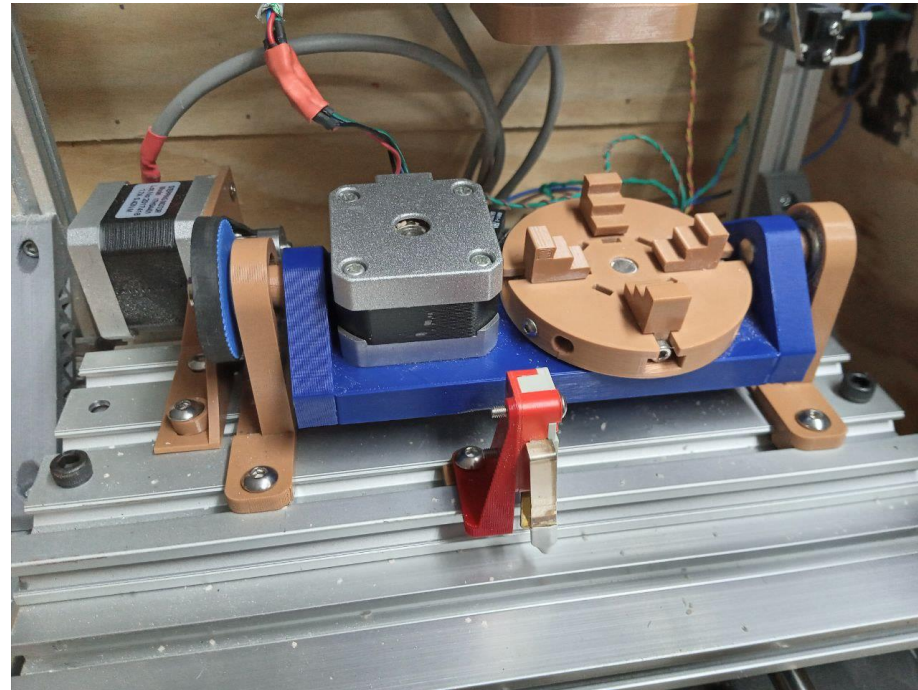
# Mechanical Base of project

- Started with a woodpecker 3018 router
- Very entry level, inexpensive desktop router
- Increase z-stroke, replace ground rods with linear rails, higher power dc motor



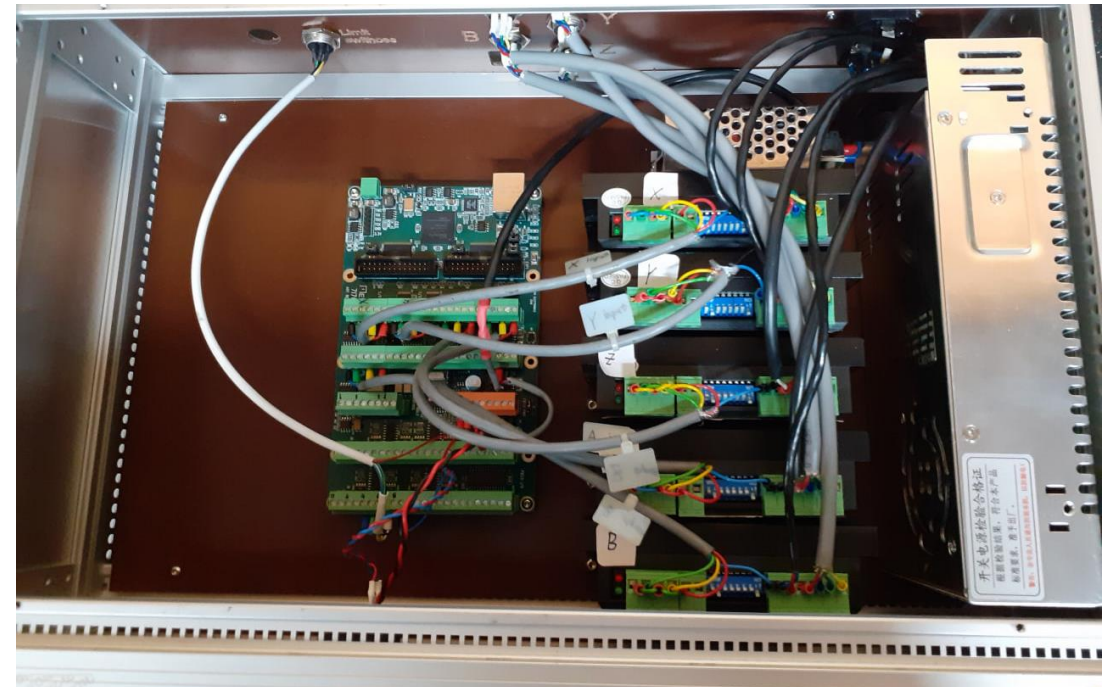
# Trunnion table

- Modified and 3d printed a trunnion table design from an Instructable
  - Not very rigid



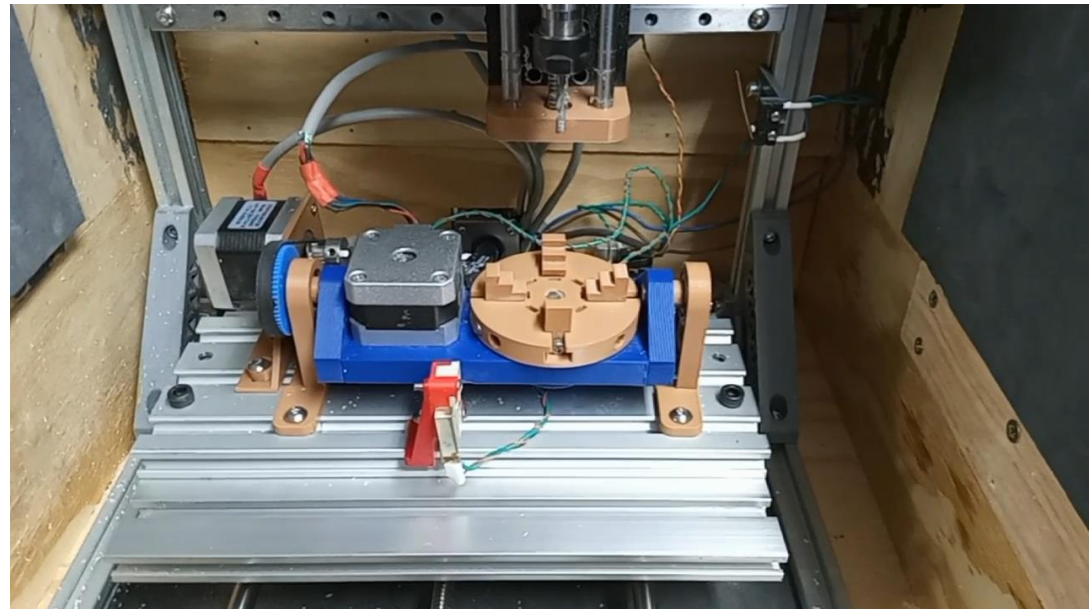
# Electronics

- Grbl controller removed
- Designed and built a box in old 19 inch rack
  - Mesa 7i76e Control card
  - 5 stepper controllers
  - 48V, 24V power supply
- Raspberry Pi 4 PC(photo)
- 5 limit switches and plenty of cabling



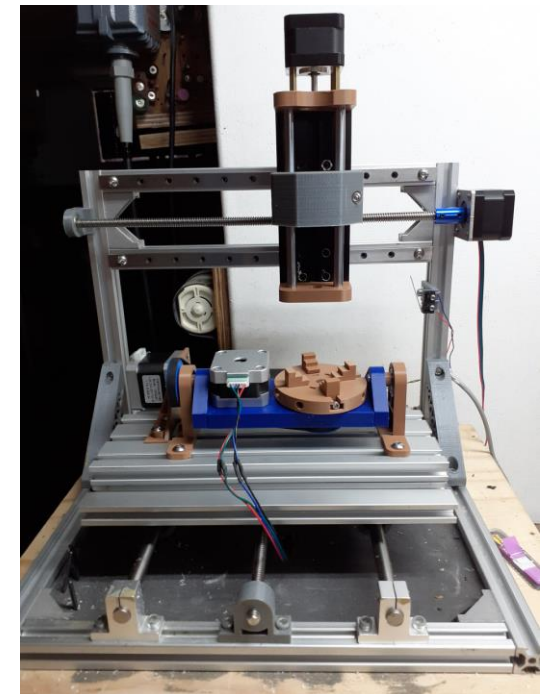
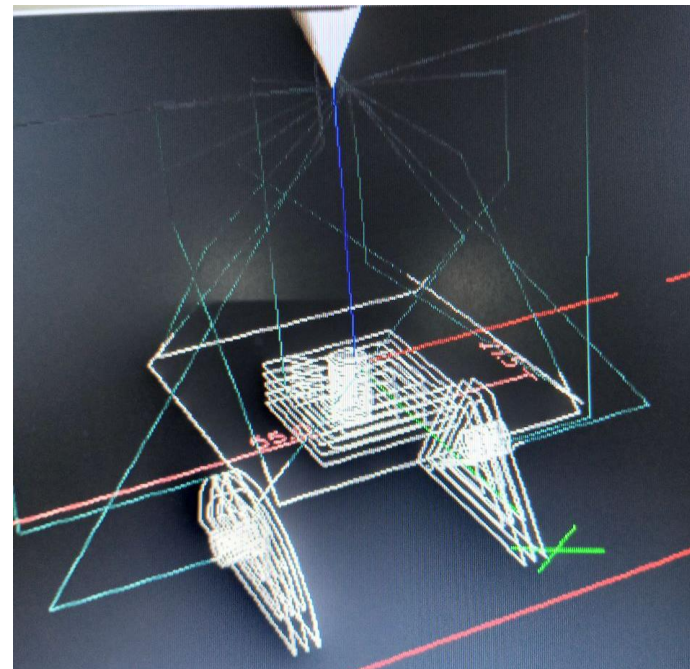
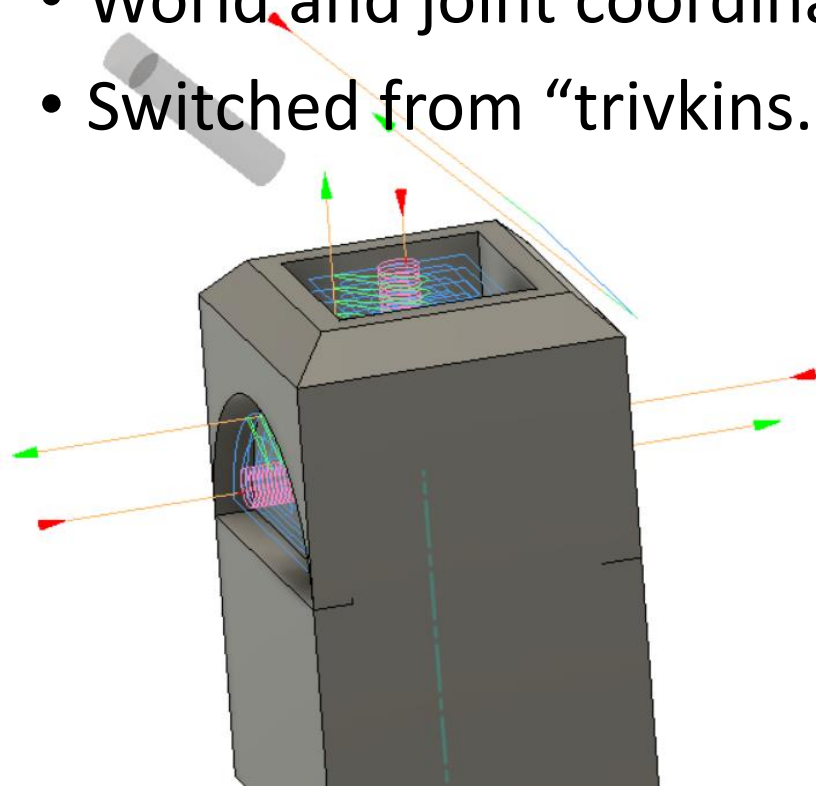
# Software setup

- Linuxcnc running on Raspberry PI 4
- Set up 4-axis machine .hal and .ini files using PNCconfig application
- Copied a-axis parameters to create additional rotary c-axis
- Played with home switches, extents on each joint to get movement correct
- Video of homing sequence:



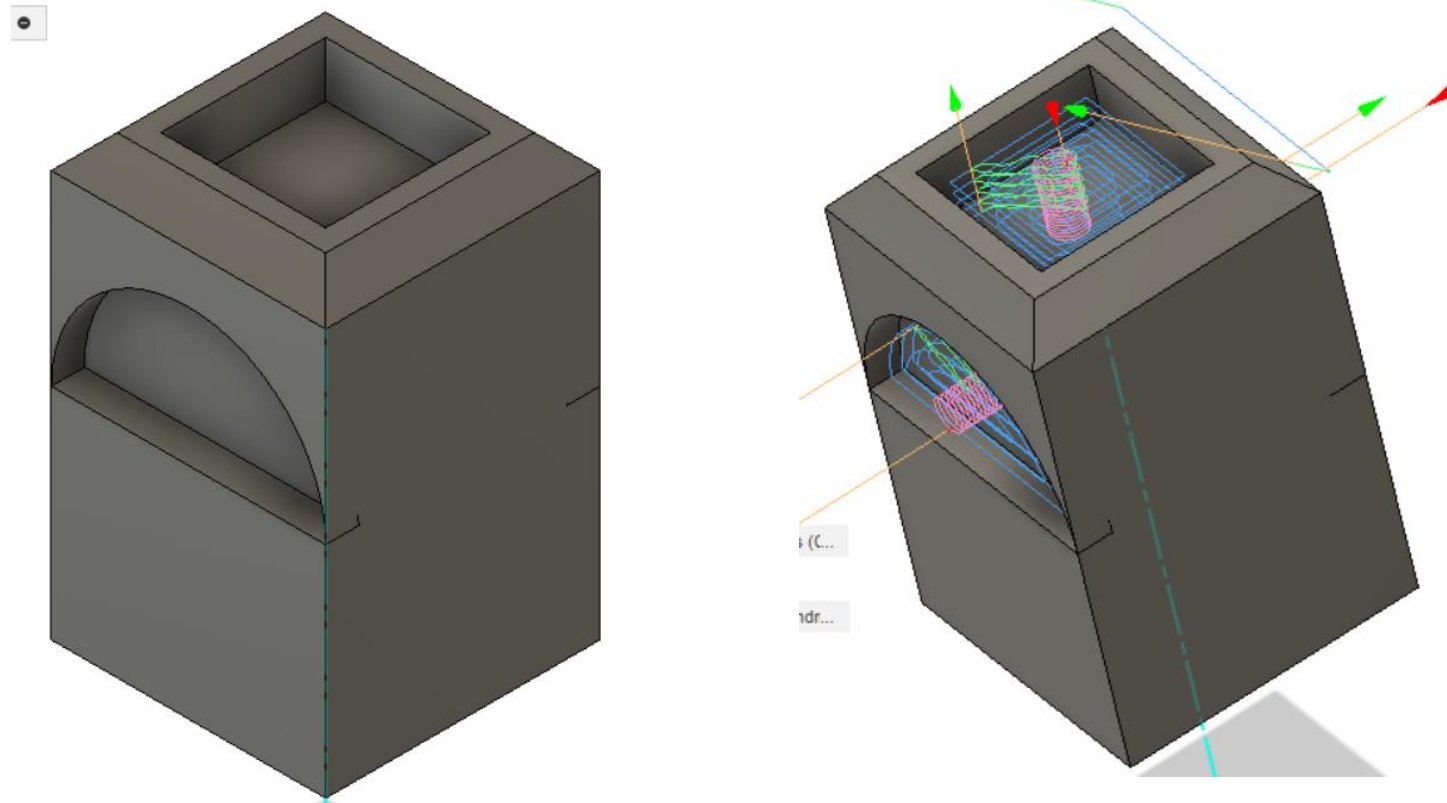
# From Trivial to Non trivial kinematics

- Joints, axes
- World and joint coordinates explanation, picture
- Switched from “trivkins.c” to “xyzac-trt-kins.c”



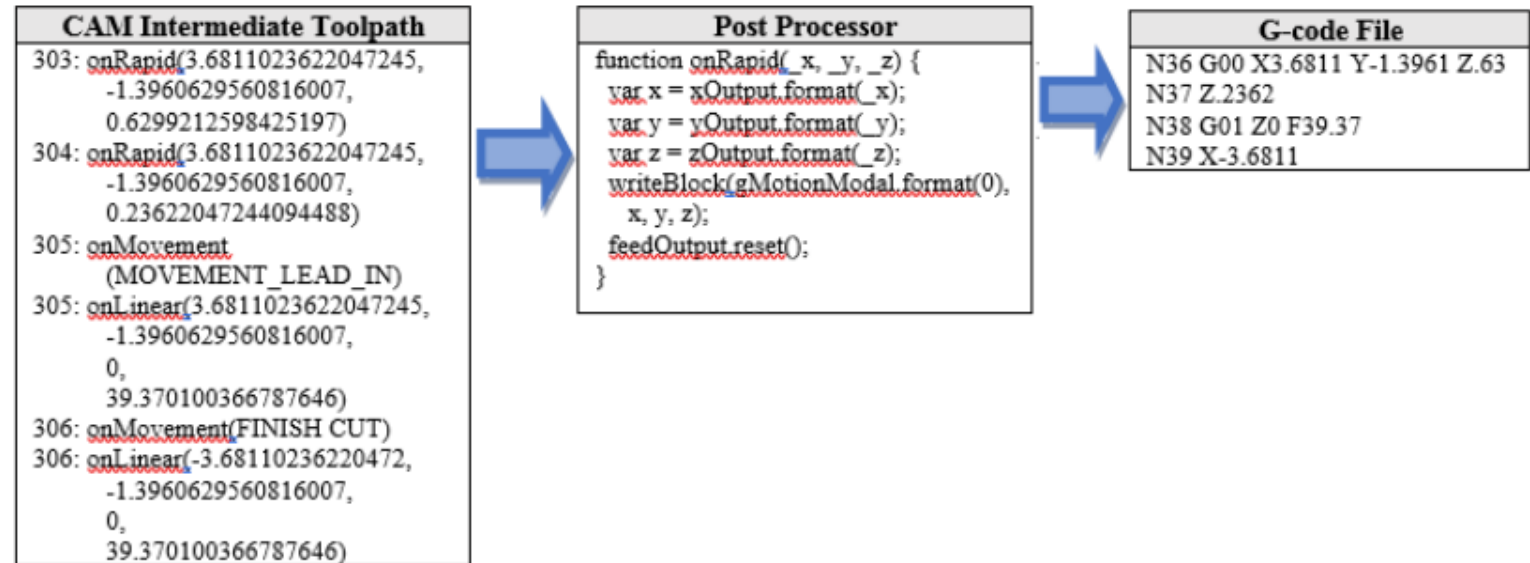
# Software workflow

- Lots of interfaces
- Designed in Fusion 360 CAD and CAM with 3+2 indexing



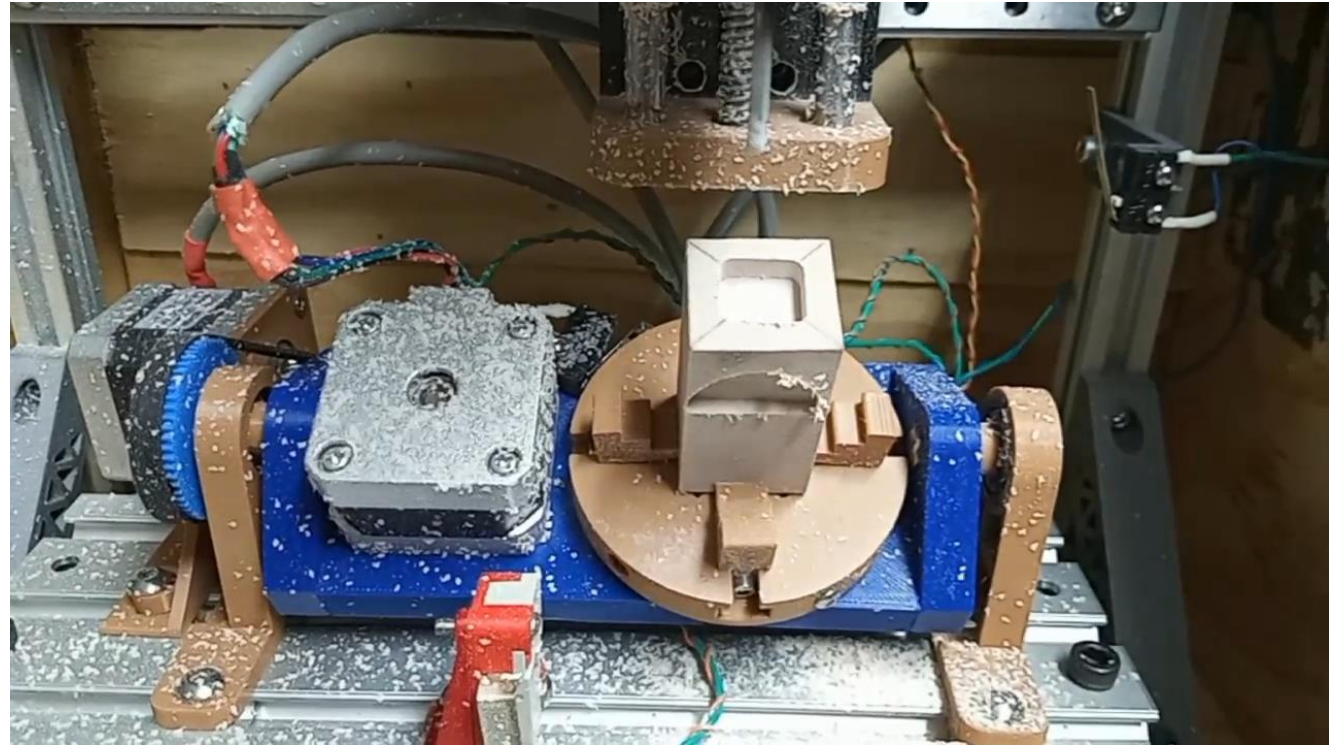
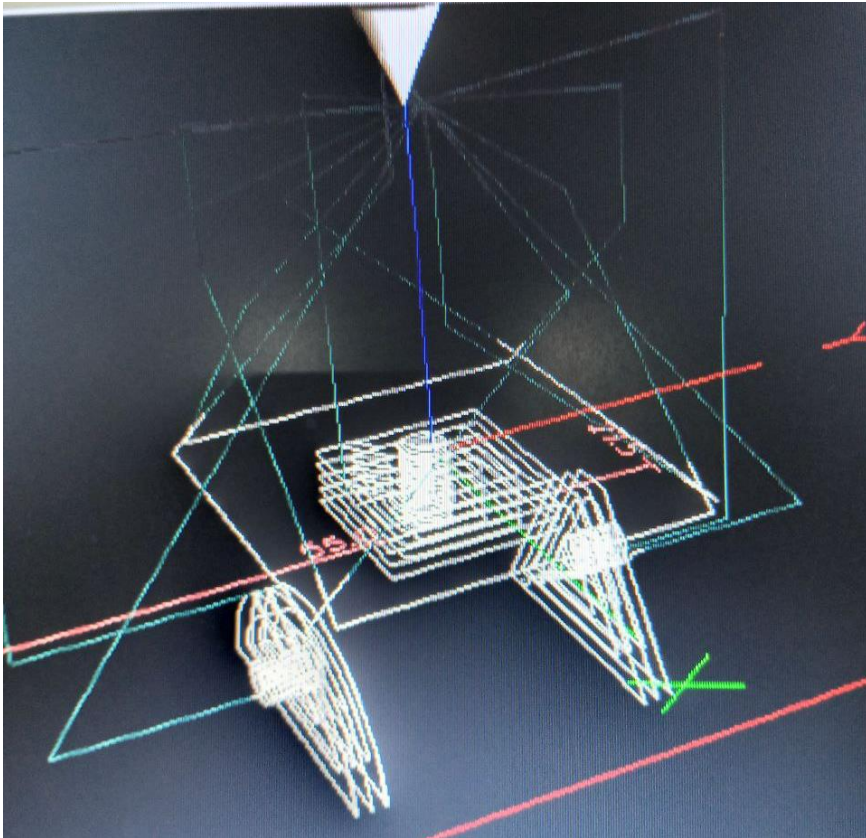
# Post Processor

- Intermediate file
- Post processor
- Gcode

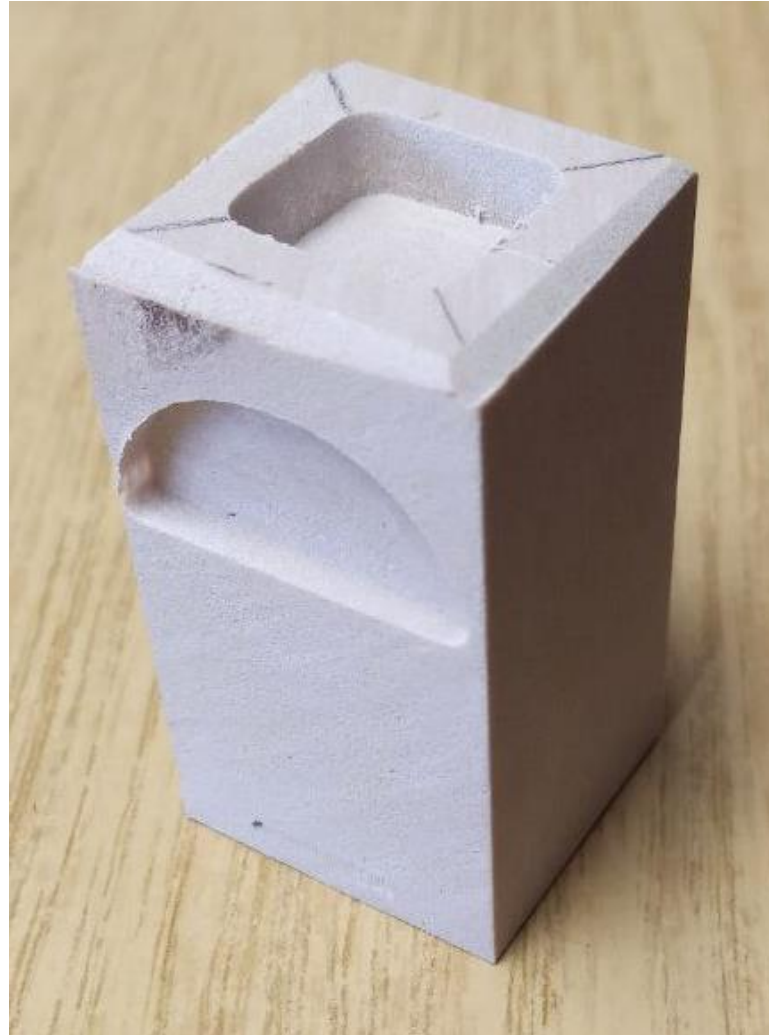


Dataflow as described in Fusion360 Post Processor training guide

# Cutting an object in Linuxcnc

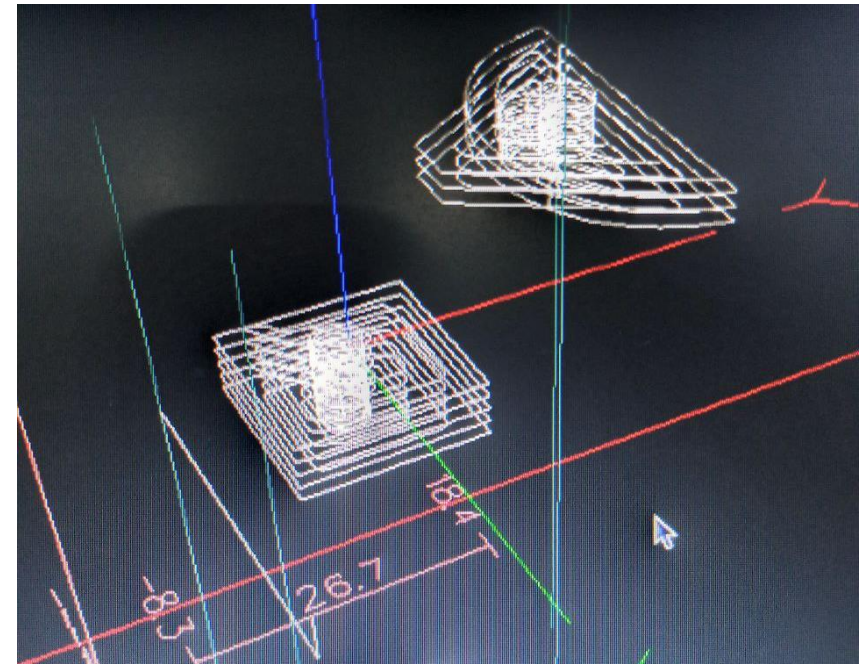


Finished cut



# Problems

- Currently place machine zero at center of trunnion table for kinematics to work correctly. Offsets?
- Have tried linuxcnc emc2 post processor.
  - Rotates operations to horizontal plane as if doing kinematics for trunnion table. Undesired.
  - In theory build kinematics of machine in machine configuration function of Fusion 360 but seems to be ignored.
  - Instead used 5axismaker post processor (head-head configuration) with all offsets 0.



- Movement between operations
  - Currently retract, move up in world z, move to safe pos, rotate to vertical, move to top of next entry point, rotate to orientation, plunge
  - Would be easier to retract, switch to joints, rotate only table to correct orientation, switch to world mode, continue
  - Switchable kinematics?

