

# Mastering 3D manufacturing devices in the ROP development workshop

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ROP group development workshop, head  
(courtesy Antonín Mík and Libor Wagner who started the activity)  
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# The aim, presentation outline

- The aim = create a single pipeline for
  - Designing 3D a object
  - Converting the design to a G-code driving a particular semi-professional “3D manufacturing machine” available in ROP group R&D workshop, i.e. allowing 3D milling / printing / laser cutting
  - Aiming at a unified procedure, which could bring under one umbrella other 3D output devices, e.g., high-quality 3D printers linked to CIIRC Industry 4.0 Testbed
- Four available 3D “manufacturing” devices

# Free software, 3D manufacturing as a service

- Using a free software as much as possible to reduce costs and enabling people to use it also in their home hobby activities
- We like to offer our 3D manufacturing capabilities as a service
  - This approach eases researchers from actual manufacturing, details and needed skill of a particular device
  - The user should “pay” for the service, i.e., by paying part of the salary of the R&D workshop staff, by some barter trade, or by money. We like to learn how to do it from the Testbed people and the Trix company
- In this seminar (a) we inform where we are right now; (b) ask the audience to provide us a feedback and/or incentives.

# Manufacturing devices in ROP R&D Workshop

- Two Průša 3D printers MK3
  - One our printer Průša MK3 printer has the cover allowing temperature control (in the room JP:B-635)
  - It enables printing from polyamide, ABS, and improves printing from other materials
- One printer Průša SL1 in JP:B-s132 working on the Mask Stereolithography principle (MSLA). A high-resolution LCD panel and a UV LED cure thin layers of resin
- A CNC 40 W laser cutting / engraving machine
- 3D CNC milling/engraving machine

# Manufacturing devices in ROP R&D Workshop

- Průša 3D printers
- 40 W laser cutting/engraving machine
- 3D milling machine (3 DoF)



# Software, operating system, our selection

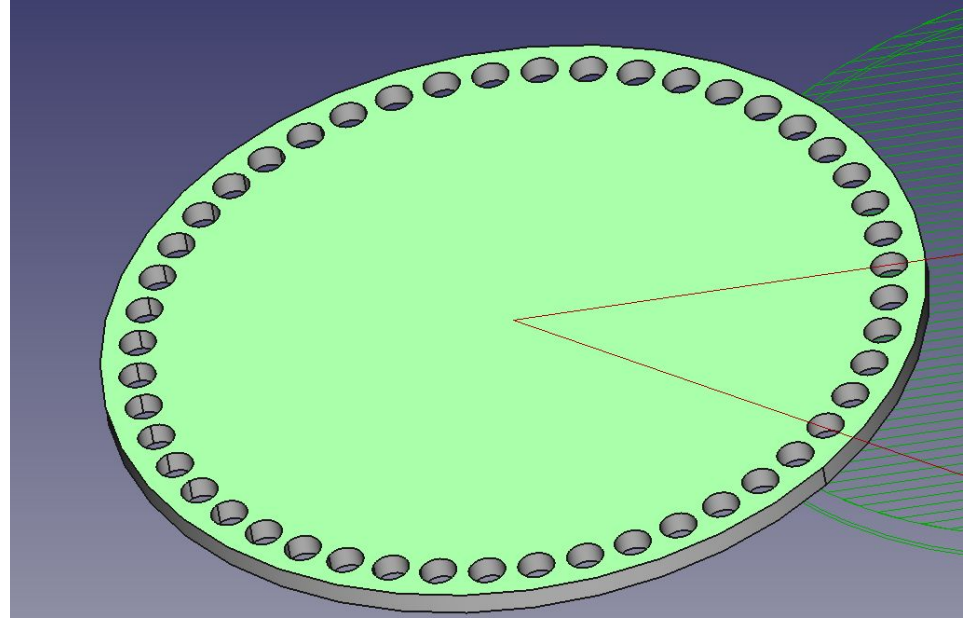
- The open-source operating system Linux (Ubuntu, Debian)
  - It is free
  - They are less demanding. We can use mediocre desktop computers as controllers for individual machine.
- The open-source 3D design tool Freecad.
  - The user can design his parts in any CAD software providing she/he can input it into Freecad.
- Vector graphics editor: We use a public domain tool Inkscape. It is needed as an intermediate representation before actual milling/engraving on a milling machine.

# Other needed software used in our pilot tests

- 3D slicer from Průša, it is free and good
- Cutting/engraving software K40Whisperer  
(an alternative to the Laser Draw (LaserDRW) program that comes with the cheap Chinese laser cutters)
- CNC control software  
LinuxCNC (Linux – kernel optimized for communication in real time)

# Our use-case

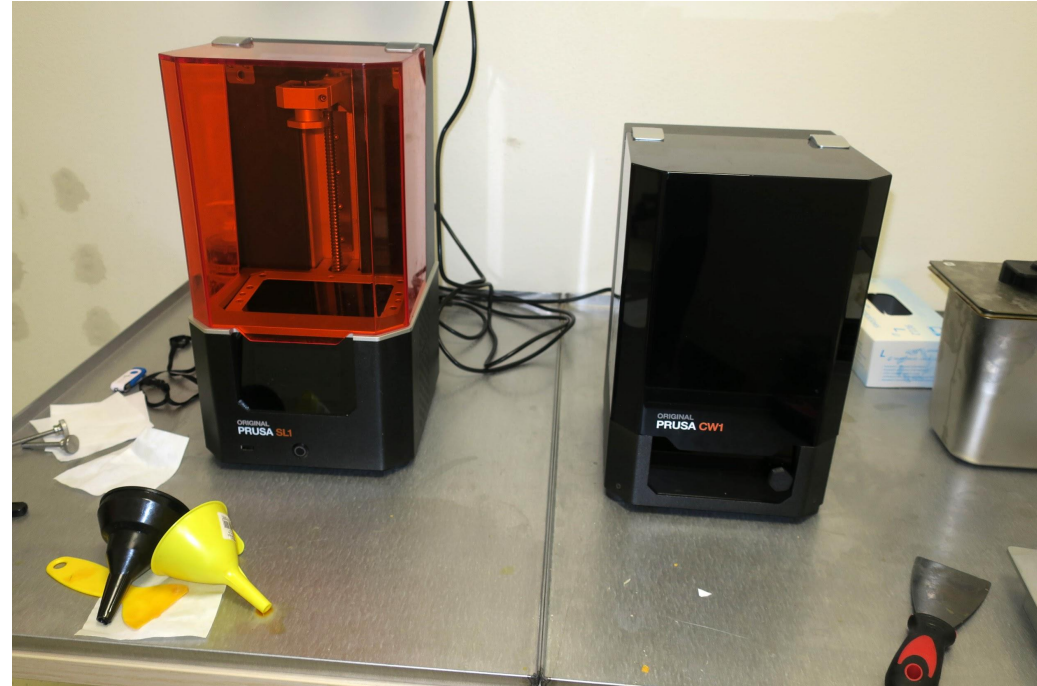
- One designed object, a disk with a ring of smaller holes close to its rim
- Designed in Freecad
- We wanted to design it and manufacture on three different devices





# Ongoing work

- Establishing instruction procedure including safety (tutorial, test, and related “paperwork”)
- Bring all three 3D “manufacturing” devices to routine operation (also in a service mode)
- “Manufacture” and gain experience
- Include Průša Printer S1 into the developed pipeline

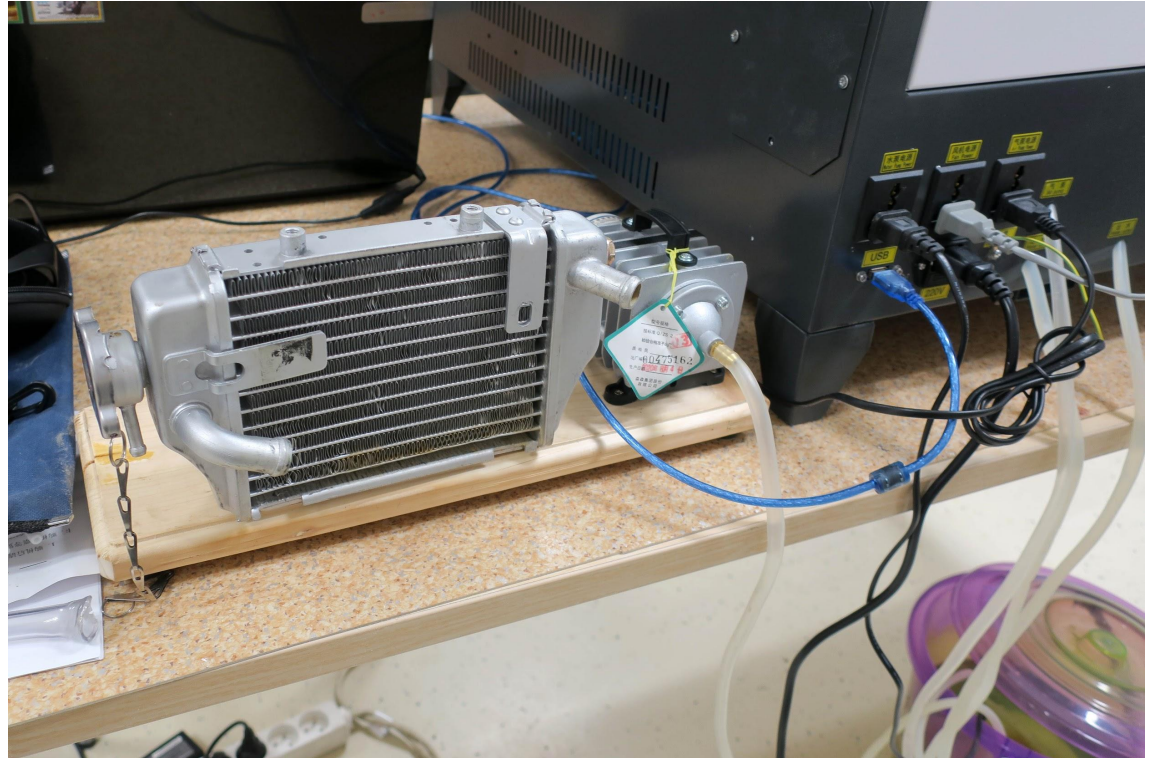


# Our flotile, 40 W laser cutter



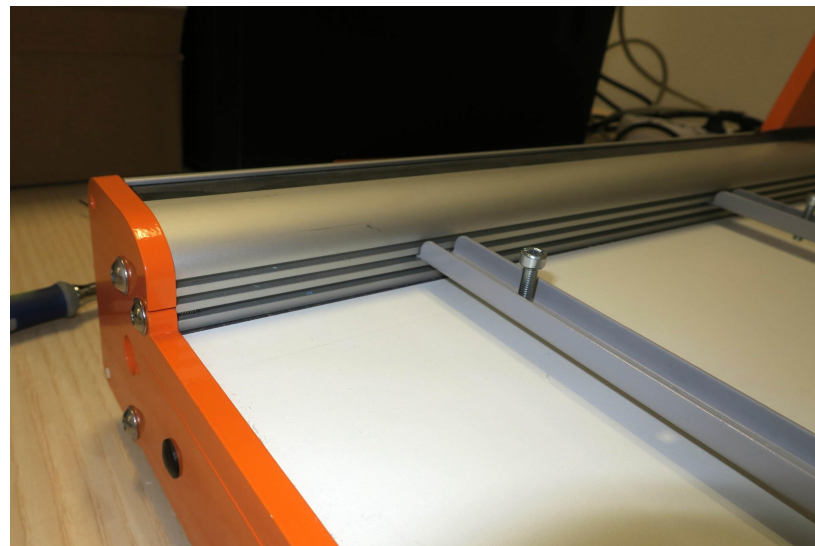
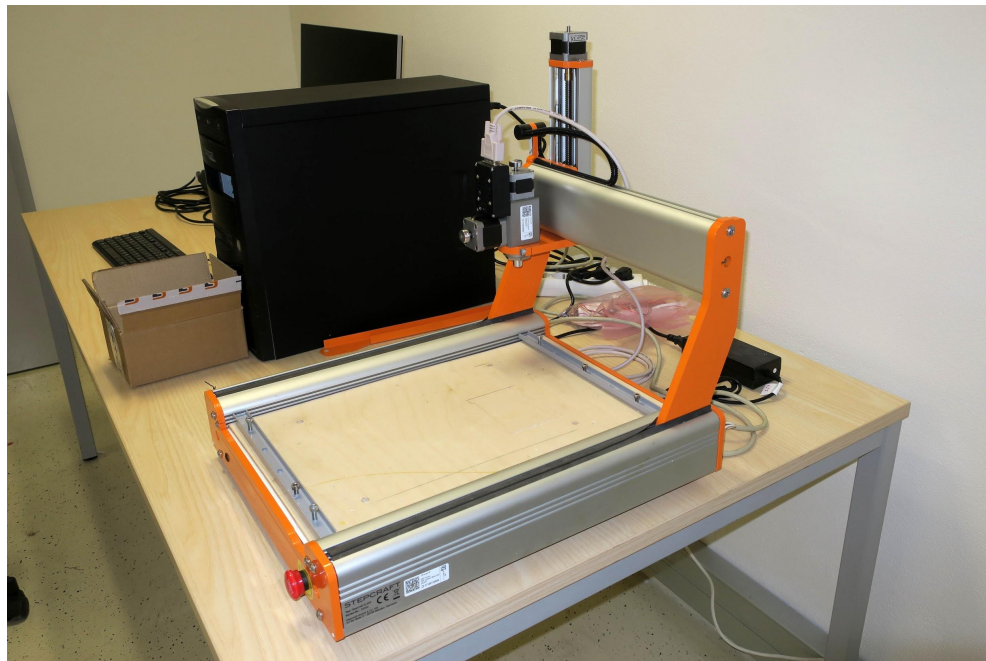
# Cooler for the laser cutter

- On our ToDo list
- Heat exchanger of the cooling liquid which cools the gas laser
- Temperature under 40 degrees Celsius
- DIY from an old motorcycle water cooler



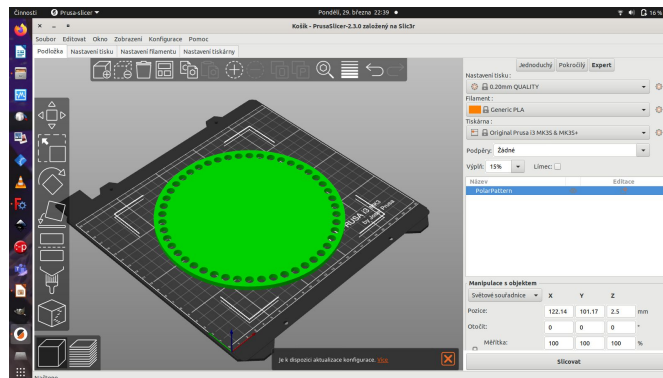
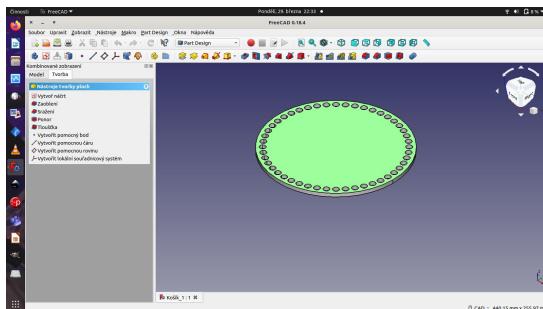


# Our flotile, 3D milling machine



# 3D printing

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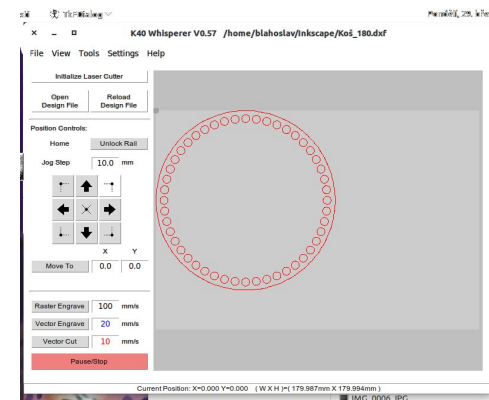
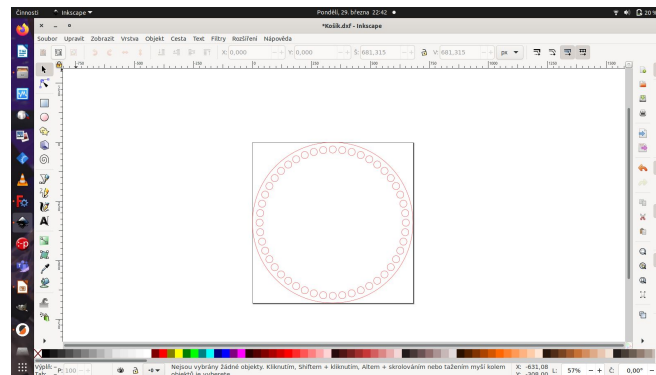
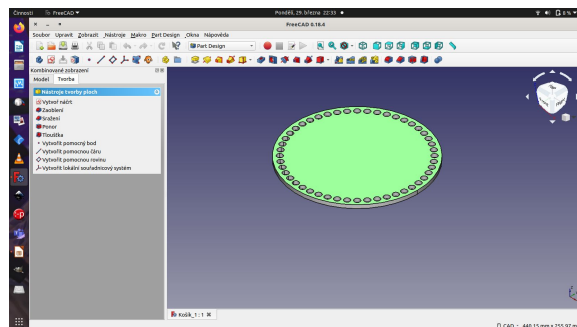
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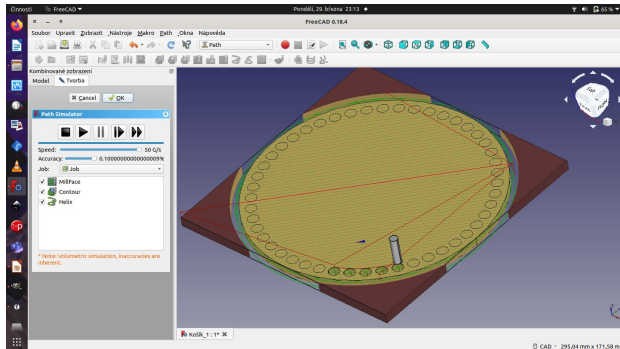
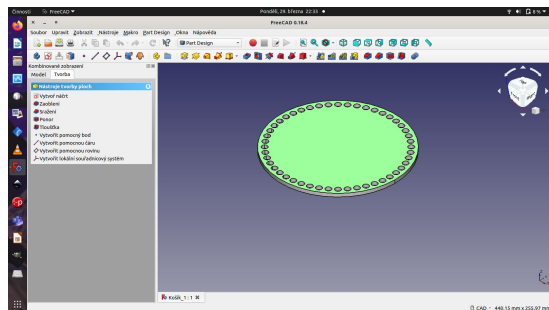
# Laser cutting

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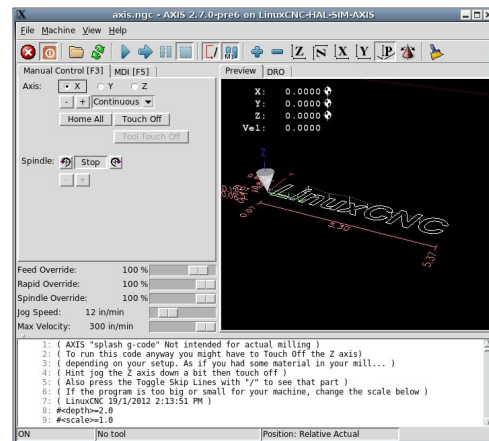
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# 3D milling



File.ngc



# Conclusions and outlook

- We (B. Dolejší, inherited from A. Mík and L. Wagner) control three devices:
  - 3D Průša printer MK3,
  - laser cutting/engraving machine,
  - CNC 3 DoF milling machine
- Laser cutter and 3D milling machine will be in temporarily the same room where other manual machines are because of dust and vapors. The big room should be kept “optical” clean. We wait for Pavel Burget’s new ventilation
- ToDo
  - Discussion with Pavel Burget and Alexander Lazarov; the aim is to unify services from the user point of view
  - Master Průša Printer S1 and include it into the developed unified pipeline