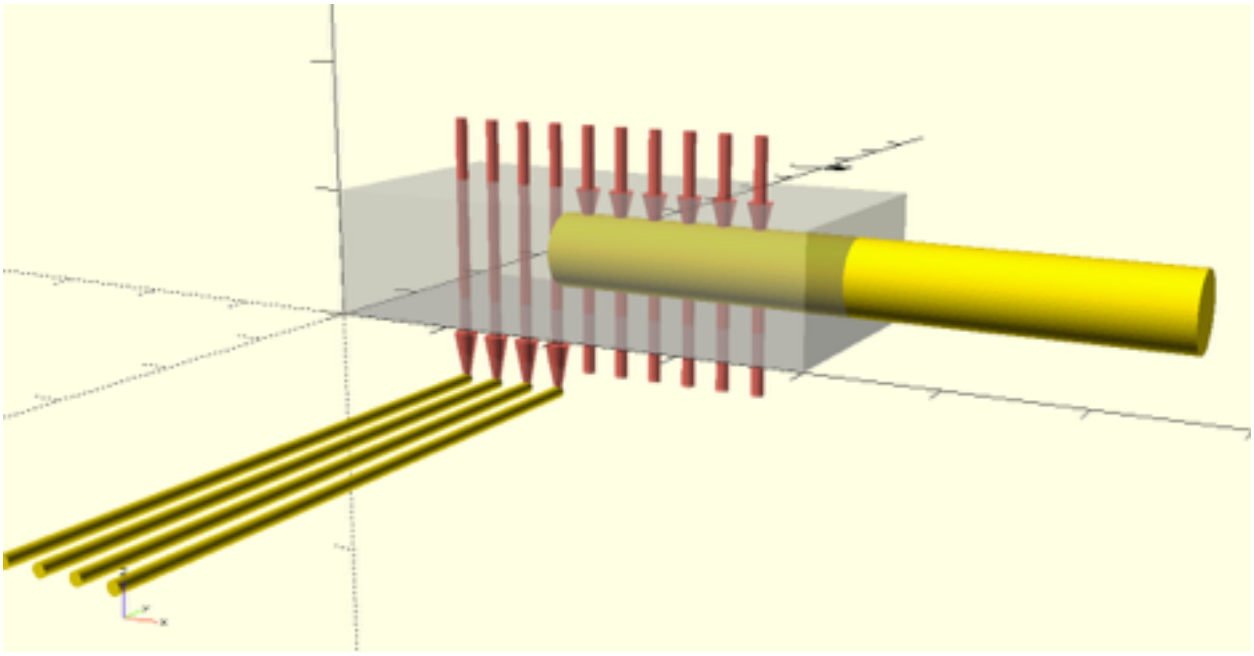
Variable-width multi-nozzle printhead.

Summary /introduction

Printing speed is one of the major limitations in printing today. The main reason for this is the fact that all printing is done using one nozzle.

My idea for a variable-width multi-nozzle printhead has the purpose to increase printing speed many times. The idea is illustrated by the following sketches:



Filament flows from the top and through the nozzles in the grey block.
From the side a rod is pushed in through a hole in the block by a variable depth.
The rod is operated by means of a servo, thus making it possible to digitally control it and pushing the rod in or pulling it out.
Depending on the depth that the rod is push in, a number of nozzles will be blocked or opened.
The filament will be extruded through 1, 2, 3, … n nozzle, creating a number of parallel extruded streams in a layer.

This will make it possible to extrude filament in multiple strands, increasing the speed of printing.

By spacing the nozzles by 3 or 4 nozzle widths, different linear fills can be created:
Spacing of 3 nozzles: 33%, 66%, 100%
Spacing of 4 nozzles: 25%, 50%, 75%, 100%

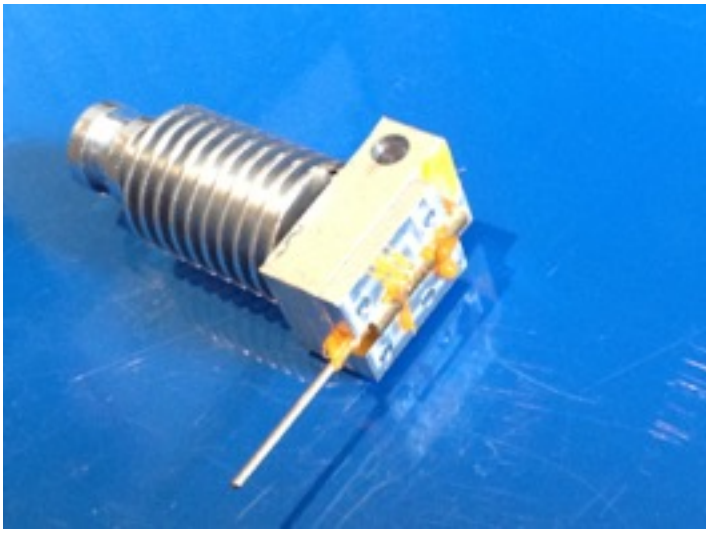
Of course, since overlapping layer must be angled, it will be needed to include 2 or 3 of the arrangements sketched above to create 90 degree or 60 degree overlap.

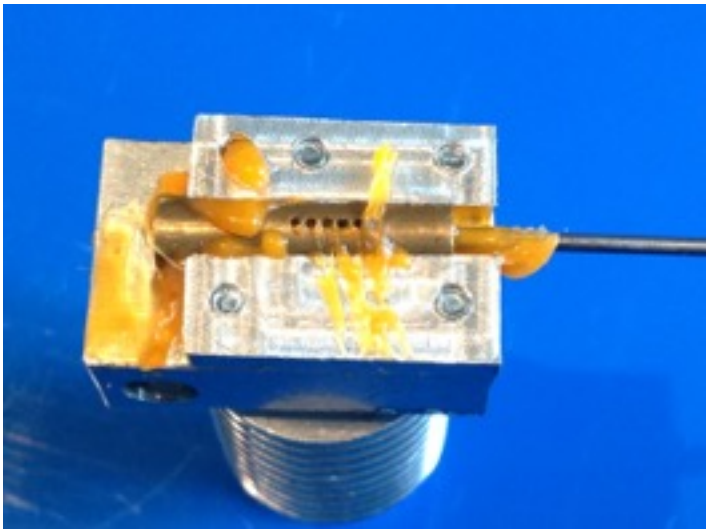
Practice/prototypes
Presently I have built 2 prototypes with limited success: I have been able to extrude PLA at different widths but I have not been able yet to perform real printing. Below please find the pictures of the prototypes but, including remarks/lessons learned.

Experiences so far:
1. Extrusion with multiple widths works properly
2. Leakage is a problem and can probably be overcome by giving the rod a teflon collar
3. Mounting instead of a normal J-head works properly, only the RVS screw need to be made longer
4. Warm-up time is longer before the rod becomes movable
5. Cooling off and warming works decent as long as there is enough thermal separation (RVS screw) between the extrusion block and the filament feeder.

To make this practically useful, a number of additional things must be implemented:
1. A servo mount to control the push of the rod
2. Layering software that will generated the proper fill patterns. The Flood fill algorithm should be usable with minor modifications.

Model 1
Pictures of actual prototype:

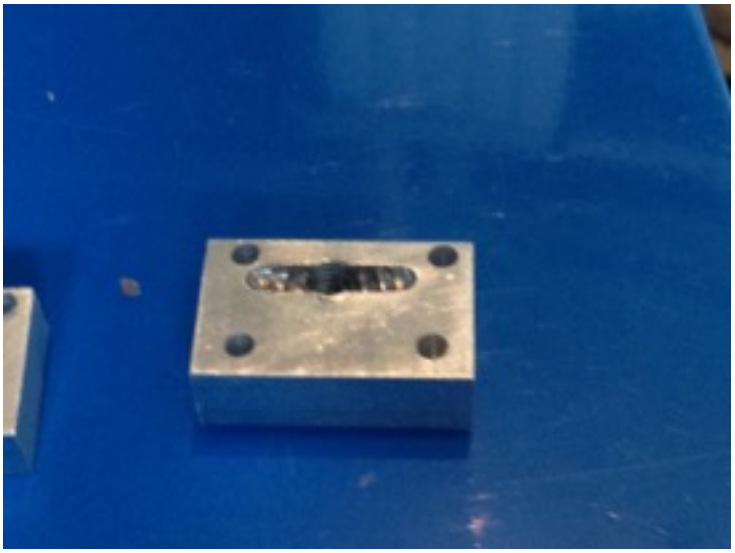




Note the leakage: the leakage around the brass cylinder can be prevented by using one block The leakage around the push-rod can probably be prevented by means of a teflon or peek collar.

New attempts, not yet built into an actual extruder.

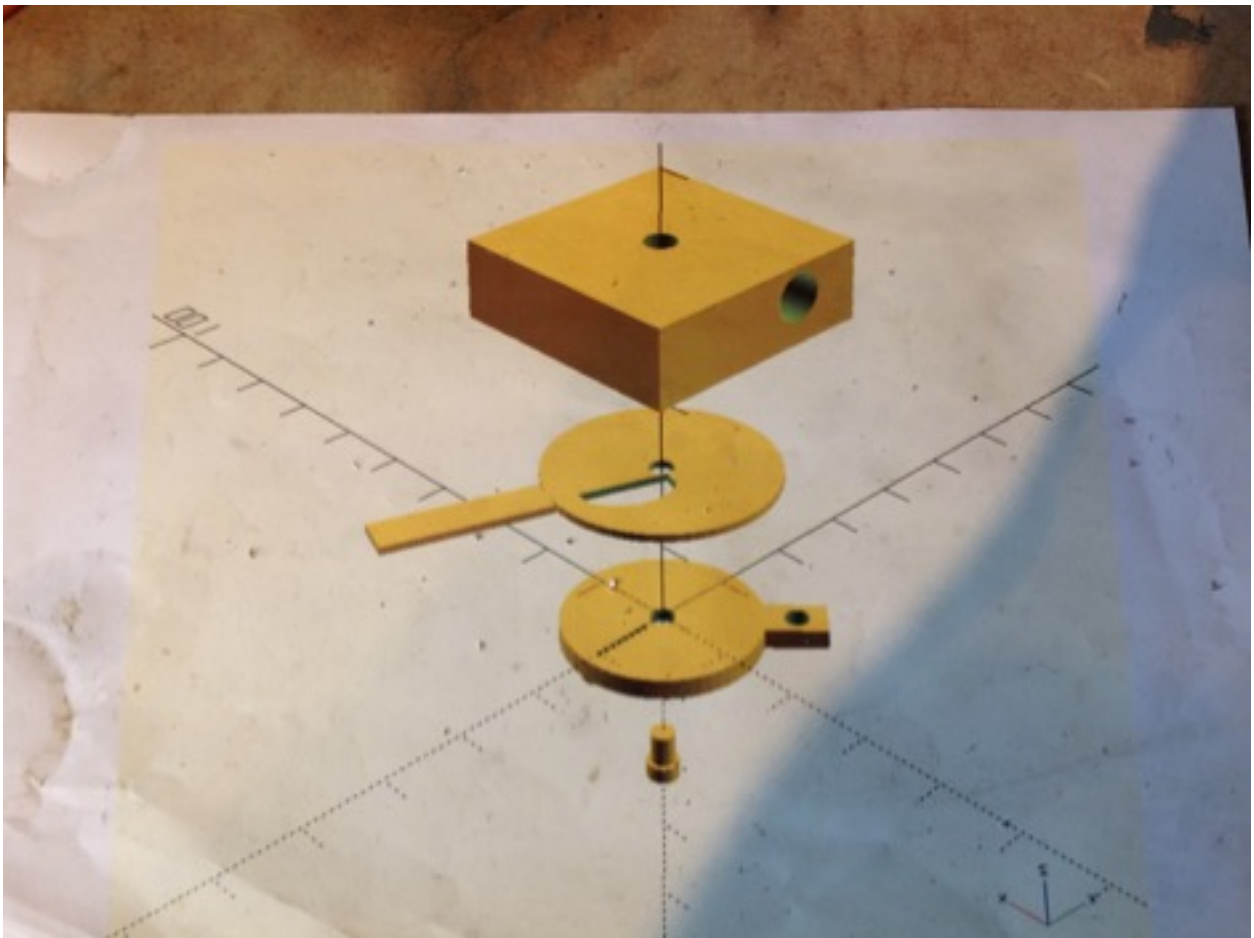
Attempt to make 1 block. Note the difficulty in drilling straight small holes.



Top part of the melting block. Note the following:
1. Channel millled to allow filament to distribute
2. Hole drilled and tapped to be able to mount as standard extrusion head

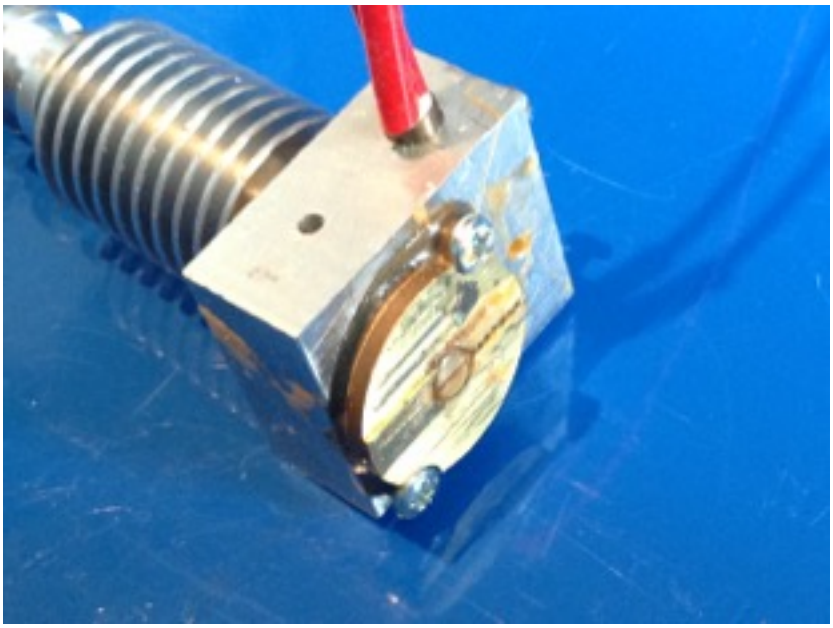
Model 2

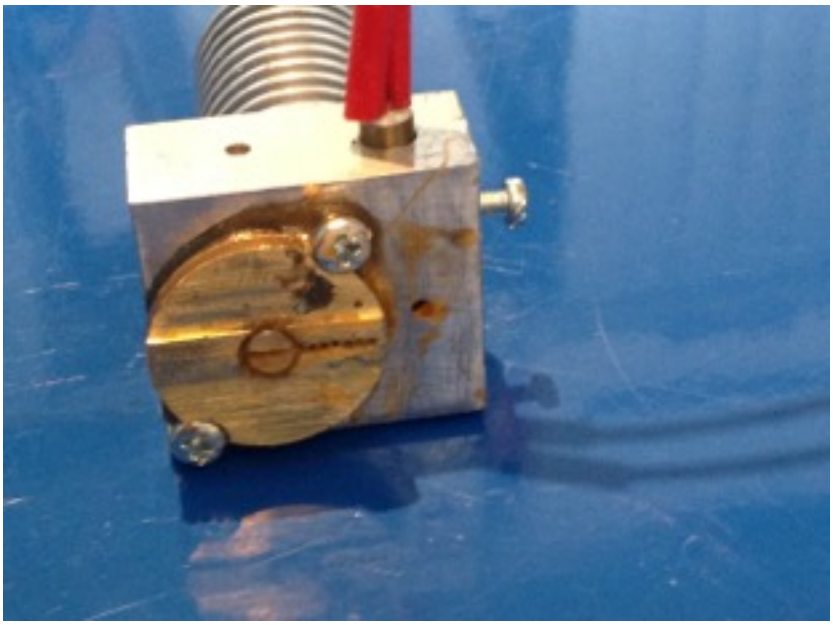
A second variant of the principle does not work with a push-rod but with a turnable valve. The principle is shown in the picture below:



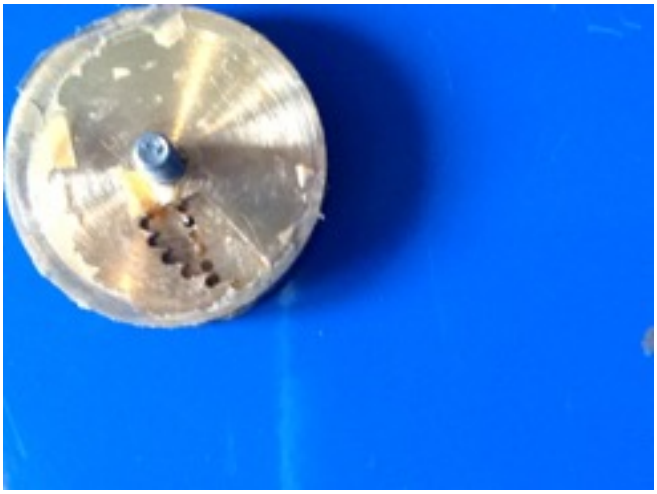
Filament flows from the top into the melting block. There are multiple extrusion nozzles in the bottom cylinder. Between the melting block and the extrusion cylinder, a rotating vale is placed. It can be rotated by the arm.

Below some foto's:

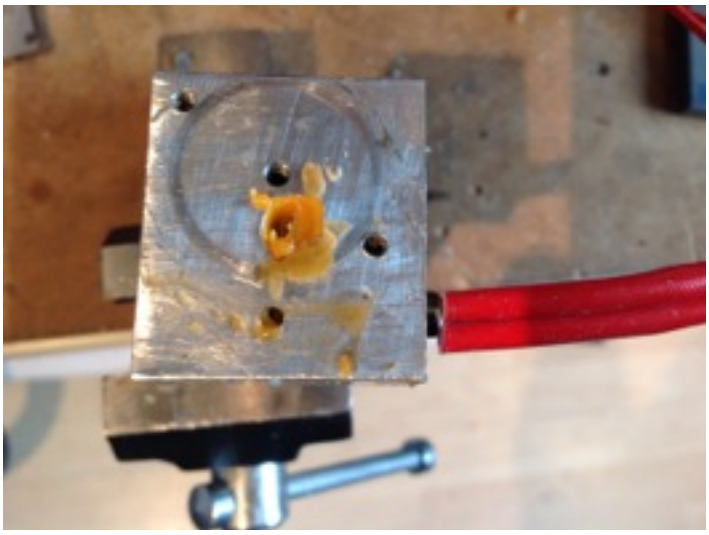




Melting block including 2 brass cylinders (the valve cylinder and the nozzle cylinder)
Leakage is quite ok, a little bit on the side. Also this can probably be reduced by using teflon rings/collars
Note the top and bottom screws to hold the nozzle cylinder in place so that it does not rotate
Not shown in the picture is that a small hole was drilled into the valve cylinder so that a rod can be inserted that can be used to rotate it.



Top view of the valve cylinder and the nozzle cylinder below. By using brass, the cylinders move quite smooth.



Top view of the block. Note the eccentric placement of the extrusion hole.

Next steps: