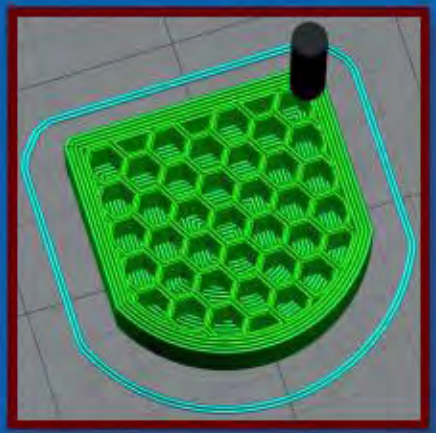
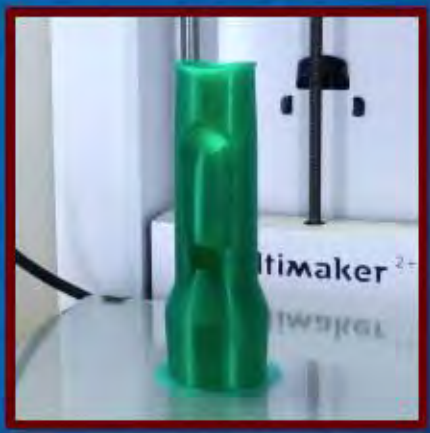
Breath Flute History and Evolution





Breath Flute History and Evolution

This is a log of the history of the design of the Breath flute and the development of the Breath Flute Project as of 8/9/2018. It includes design prototypes as well as details on individual print renderings.

This log serves several (occasionally competing) purposes:

- To document the (vast) myriad of choices and selections made in the multitude of parameters, choices, and variables that present themselves, allowing them to be re-used for later work.
- To log lessons learned and ideas for continued development (this means a lot of pictures of failed prints – some of them spectacular).
- To document the motivation and reasoning behind various design choices.
- To satisfy my "archivist" nature, to the extent that it might be useful for subsequent developers.

You can access Web-based information on the Breath Flute as well as the latest distribution package at http://www.BreathFlute.com/. The latest version of this *Breath Flute History and Evolution* is at:
http://www.BreathFlute.com/pdf/BreathFlute_History.pdf

You may also be interested in these documents:

- *A Brief Introduction to the Breath Flute*:
  http://www.BreathFlute.com/pdf/BreathFlute_Introduction.pdf
- *Breath Flute Developer's Guide*:
  http://www.BreathFlute.com/pdf/BreathFlute_DevelGuide.pdf
- If you use Simplify3D as your slicer, you may get something from my *Simplify3D Settings Manual*, available at http://www.BreathFlute.com/pdf/S3D_ProfilesCG.pdf
- If you use a Prusa i3 Mk3 printer with Simplify3D for a slicer, you might be interested in these ZIP packages of printer profiles:

- Simplify3D Profiles Comparison:
  http://www.BreathFlute.com/zip/S3D_Pi3Mk3_CoreProfiles_CG.zip
- Simplify3D Prusa i3 Mk3 Clint Goss Breath Flute Profile 20180504:
  http://www.BreathFlute.com/zip/S3D_Pi3Mk3_CG_BF_20180504.zip

Please realize that this document was sometimes used as my "scratchpad" for thoughts and To-Do lists … you may find some (or all!) of it tedious.

The entries for #1 through #11 were developed from memory on 8/29/2016 since I was about to paint all the existing breath flutes black, and the historical info written on the side would have been lost. (However, I eventually decided not to paint the prototypes.)

The list is mostly in time order of design/construction.

— Clint Goss [clint@goss.com], as of 8/9/2018

Acronyms and Abbreviations

CG Clint Goss.

Ckfill Corkfill – a filament by ColorFabb consisting of PLA, PHA, and Cork fibers.

FCMG Fairfield County Maker's Guild in Norwalk, CT.

FFCP FlashForge Creator Pro.

FFCP/FCMG The FlashForge Creator Pro at the ***Fairfield County Maker's Guild***.

FFF "Fused Filament Fabrication" – the method used by 3D Printers. This is actually a copyrighted term of the RepRap project, licensed under GPL.

FDM "Fused Deposition Modeling" – an alternate description of FFF.
https://en.wikipedia.org/wiki/Fused_deposition_modeling

GPL "GNU Public License" – an open-source license

InPLA Taulman3D In-PLA – see specs

MgPLA MakerGeeks PLA – recommended print temperature is 230°C (!)

MhPLA Matter Hackers Pro PLA – recommended print temperature is 205±15°C

nGen ColorFabb nGen – a filament made from Amphora AM3300.

Pi3Mk2 or **Pi3m2** Prusa Research Original Prusa i3 Mark2. This is often dubbed "MK2" on newsgroup messages. Pi3Mk2 is the preferred acronym, but Pi3m2 was used in the past in some of the file names for S3D profiles and factory files.

Pi3Mk2/FCMG The PiMk2 at the ***Fairfield County Maker's Guild***.

Pi3Mk3 Prusa Research Original Prusa i3 Mark3. Often dubbed "MK3" on newsgroup messages.

Pi3Mk3/CG Clint's Prusa Research Original Prusa i3 Mark3. It was ordered on 11/19/2017 and it arrived on 4/2/2018, setting a record for "later than promised".

PEI Polyetherimide – A polymer frequently used for print beds to facilitate prints that "stick to the bed": https://en.wikipedia.org/wiki/Polyetherimide. Note that "PEI" also stands for a completely different polymer: Polyethylenimine (aka Polyaziridine) https://en.wikipedia.org/wiki/Polyethylenimine. See information at https://en.wikipedia.org/wiki/Talk:Polyethylenimine regarding physical characteristic and solubility in acetone.

PRF "Peter Riley Fujara" – a "gold standard" for breath flute sound (see ***Fujara / Breath Flute #1***).

RiPLA Rigid.Ink PLA – "pure" PLA with a recommended print temperature of 180°C (!).

S3D "Simplify3D" – slicer software.

SLA "Stereolithography" – an optical fabrication resin printing technology a layer-by-layer fashion using photopolymerization.

SSS "Spring Steel Sheet" – the print bed on Prusa printers, typically covered with PEI sheets or powder coatings on both sides.

TNE "Trial and Error" – a technique for determining a given parameter or value in the code by trying different values and visually inspecting the results.

UM2+ or **UM2p** "Ultimaker 2+". The UM2p acronym is used in situations where "+" characters are not allowed / encouraged (file names).

UM2+/FCMG The Ultimaker 2+ at the ***Fairfield County Maker's Guild***.

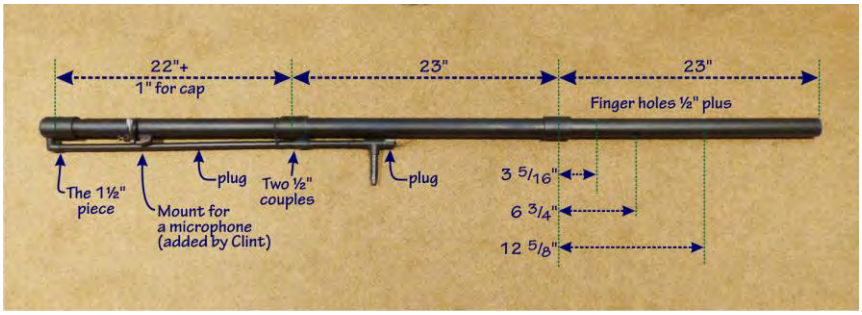
YAFF "Yet Another Fudge Factor" – an acronym used in the OpenSCAD source code to mark arbitrary parameters used to "fix things".

Initial Models for Breath Flutes

Initial inspiration for breath flutes, plus some early experiments …

Fujara / Breath Flute #1

Fujara crafted by Peter Riley (Blairsville, Georgia), May 10, 2006. 1¼" Schedule 40 PVC.

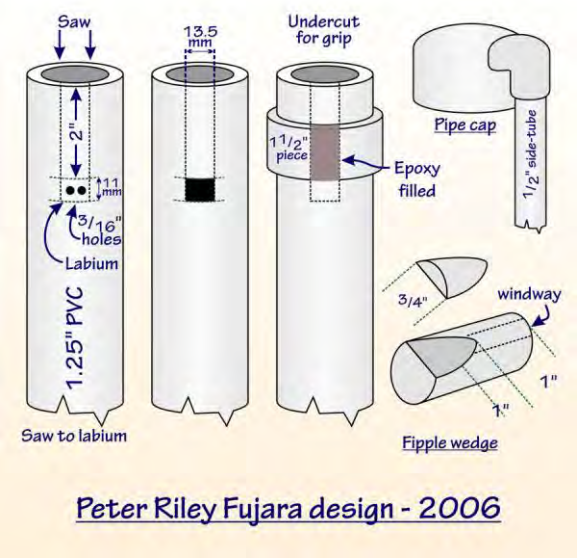


The construction for this instrument was documented by Peter and Charles Parker in two documents, both available on Flutopedia:

[Riley 2006] Peter Riley; Charles Parker (editor). *Notes on Making a Large Overtone Flute (the Fujara) from Readily Available Materials*, November 5, 2006, 10 pages. Available at http://flutopedia.com/refs/Riley_2006_FujaraConstruction.pdf

[Riley 2009] Peter Riley. *Additional Notes on Making a Large Overtone Flute*, January 8, 2009, 3 pages. Available at http://flutopedia.com/refs/Riley_2009_FujaraConstructionAddition.pdf

Figure 2 from the first of these documents is shown at the right. It details the construction of the nest area of the instrument.



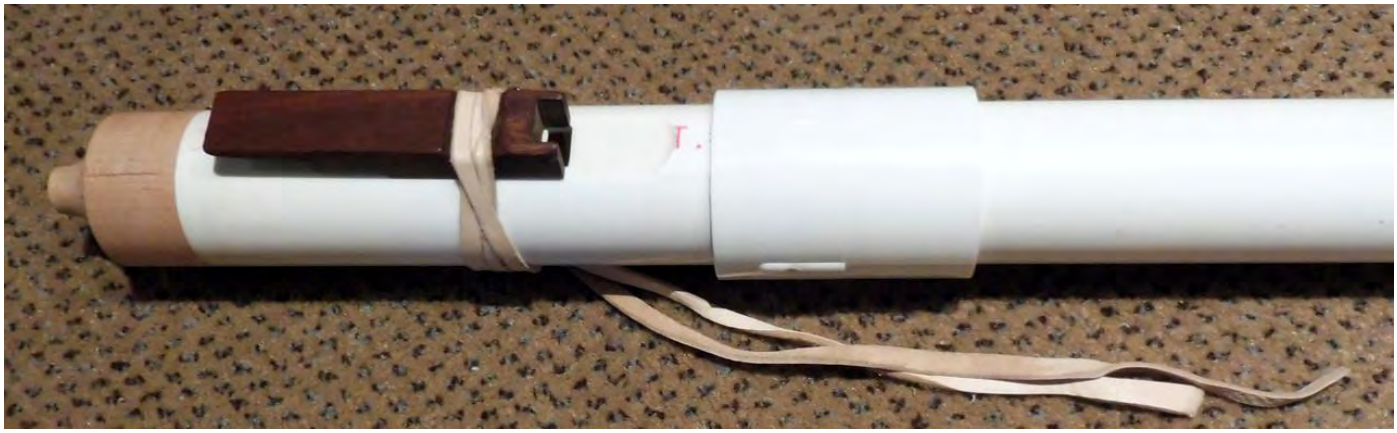
That instrument was re-purposed early 2016 for use as a breath flute. Originally done by simply removing the lower third of the Riley fujara. This produced a fundamental of about 30 cents flat of D3.

Lower section of Class 160 PVC / SDR 26 cut on August 29, 2016 to tune it to a D3. This flute was not marked with a Sharpie, since it was relatively unique.

This instrument, using somewhat shorter body tubes for higher pitches, became the "gold standard" for the Breath Flute, in terms of sound. It is often designated in code and later in this document as "PRF" (Peter Riley Fujara).

Breath Flute #2

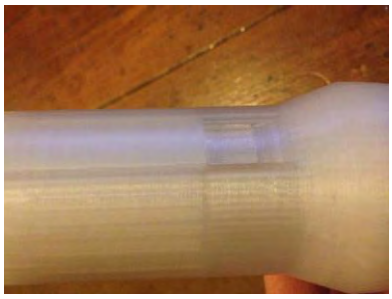
Native American flute style headjoint with a wood block crafted by Jon Norris, June 1, 2015. 1¼" Schedule 40 PVC.



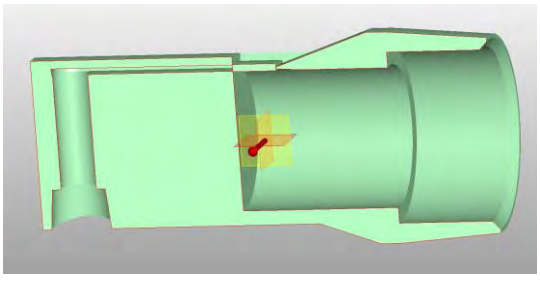
Made by Jon at Clint's request to use for testing of the Miyako Bushi style of flute. When used as an overtone Breath flute, the sound is not terrible, but there are not many overtone registers.

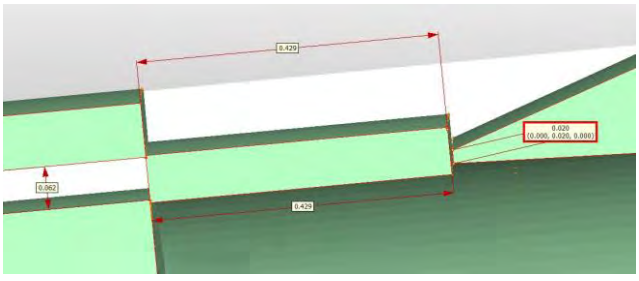
Creo Fujara Cap

3D Printing design of a "fujara cap" by user Creo on YouMagine.com, posted January 4, 2016 under CC-BY-NC-SA. A photo of a printed version provided by Creo looked like this:

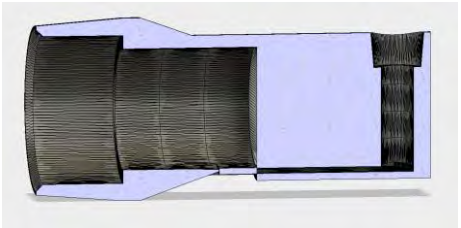


The design published on-line by user Creo provided an `.STL` file with a single mesh. These images were produced by Clint from the STL file using 3D-Tool FreeViewer V12 on April 6, 2016:





This rendering is a cross-section of the Creo design, provided by Vladimir Mariano on May 7, 2016:



Creo Fujara Cap 3D Print

A 3D print in Grey PLA from the Creo Fujara Cap `.STL` file done by Jon Norris's neighbor on or before April 13, 2016:

Rather rough, with printing issues (according to Vladimir). Sound is "not so great".

Breath Flute #2.5

Breath flute prototype crafted by Clint Goss, April 1, 2016. 1¼" Schedule 40 PVC. *Not very good!*

Jon Norris PVC Prototypes

Developed by Jon Norris and Clint Goss on a trip by Clint to Jon's shop in Holly Springs, North Carolina in April 2016.


These are loosely based on Jon's design for his wooden Irish whistles:


Breath Flute #3

First breath flute crafted by Jon Norris the week of April 11, 2016 in North Carolina with Clint.

1¼″ Schedule 40 PVC for the whistle, 1¼″ Class 200/SDR 21 PVC for the sleeve, and a wooden plug. Initially labeled in pencil: "Proto #1".

Breath Flute #4

Experiment to narrow the windway. Crafted by Jon Norris April 14, 2016. 1¼″ Schedule 40 PVC for the whistle, 1¼″ Class 200/SDR 21 PVC for the sleeve, and a wooden plug.


Initially labeled in pencil: "Proto 2a Narrow 4/14/2016".

Breath Flute #5

Experiment to widen the windway. Crafted by Jon Norris April 14, 2016. 1¼″ Schedule 40 PVC for the whistle, 1¼″ Class 200/SDR 21 PVC for the sleeve, and a wooden plug.

Initially labeled in pencil: “Proto 2b Wide 4/14/2016”.

Breath Flute #6 – #10

Five breath flute headjoints (sleeves and whistles) crafted the last day in North Carolina (April 15, 2016, I believe) by Jon Norris so that we could try out the group playing concept at Flute Haven 2016. I think these are essentially the same design: All 1¼″ Schedule 40 PVC for the whistle, 1¼″ Class 200/SDR 21 PVC for the sleeve, and a wooden plug.

#10 given to Vladimir Mariano <vladimir.mariano@gmail.com> on 9/23/2016 to build a Fusion360 model. This was returned November 4, 2016 at the completion of the 30-series prototypes.

Breath Flute #11

The final breath flute headjoint crafted on April 15, 2016 by Jon Norris.

This was the last of the set of six breath flutes, crafted like #6–#10, except that it has an extra PVC “clamp” that sort of looks like a bird/block on a Native flute. Maybe this would be useful to attempt to affect tuning on the flute??

Field Test

Breath flutes #3 – #10 were fitted by Clint with couplers and bodies all tuned to D_3 and taken to Flute Haven 2016, September 11–18, 2016. They were used during the evening drum jam – unannounced to get an authentic reaction from the participants (all flute players). The reaction was overwhelmingly positive.

The next day, they were taken to the concert at Camphill (at the suggestion of the participants):

Vladimir Prototypes – The "20-Series"

A series of designs in Fusion 360 created and printed by Vladimir Mariano in early October 2016 as a demonstration of the possibilities.

Breath Flute #21

Whistle component designed in Fusion 360 by Vladimir Mariano, October 7, 2016, and printed in light grey PLA. Shown to the right.

This design has a flange on the flue portion of the whistle, making it impossible to slide the sleeve onto the whistle.

Also failed because the internal plug is porous, and the foot end of the whistle has too large a diameter for the PVC coupler.

Breath Flute #22

Whistle component designed and printed between October 7 – 29, 2016 by Vladimir Mariano in translucent Yellow PLA. Issues:

- Splitting edge is wavy and imprecise
- The foot is diameter is too small to fit a PVC coupler
- Plug is somewhat porous

Breath Flute #23

First workable prototype by Vladimir! Printed between October 7 – 29, 2016 in translucent Yellow PLA. The splitting edge is much better (monitor printing temp during printing of the splitting edge), the diameter of the foot was corrected, and a thin, flexible 3D printed "flap" was inserted into the top of the whistle to correct problems with the porous plug.

Sleeve #23a

A 3D-printed sleeve in light grey PLA on an UM2+ printer. This provided a good comparison against the smooth PVC sleeve – to demonstrate the effect of the ridges in the flue on 3D printed components.

Breath Flutes #24 & #25

3D Prints failed, for unknown reasons. However, these are useful because they show various issues with low infill and a solid inner and outer wall.

Breath Flute #26

Printed in light blue PLA, in two parts that fit together to make a complete whistle component. The two halves to fit together fairly nicely, but the design prevents the sleeve from moving all the way up to the end of the flue.

Vladimir Prototypes – the "30 Series"

A series of prototypes developed and printed by Vladimir Mariano in Fusion360 during the week of November 1 – 4, 2016, all printed in dark grey PLA on a MakerBot Replicator 2 printer. These flutes play quite well!!

These notes on each design transcribed from Vladimir's notes on November 4, 2016:

Breath Flute #31

Printed in dark grey PLA on a Replicator 2 at 0.2mm vertical resolution and 230 °C. Issues:

- The diameter of the foot end is slightly too small for a PVC coupler
- There is a very slight hairline gap in the splitting edge – interesting issue solved in later prints

Breath Flute #32

This print failed for some reason, and was discarded by Vladimir.

Breath Flute #33

Outside diameter of the foot end of the whistle fixed to match a PVC coupler. However, the top bevel angle was accidentally changed.

Pretty good sound!

Breath Flute #34

Outside diameter of the foot end of the whistle tweaked slightly. Top bevel angle restored to the original design.

Sound is very good!!

Breath Flute #35

Printed in dark grey PLA on a Replicator 2 at:

- 0.3mm vertical resolution and 230°C from the foot up until the distal end of the top bevel (i.e. where the bevel begins to print)
- 0.1mm vertical resolution and 230°C up until the distal end of the flue (i.e. the "lip")
- 0.1mm vertical resolution and 210°C (to reduce issues with sagging of the lip) through to the top of the whistle component.

Breath Flute #36

Printed in dark grey PLA on a Replicator 2 at 0.2mm throughout and a temperature of 200°C.

This design incorporates a concave shape for the top of the sound chamber.

Sanded a bit with 220 grit on the upper portion of the whistle component.

Sleeve #36a

A 3D-printed sleeve in dark grey PLA on a Replicator 2 printer. This provided a good comparison against the smooth PVC sleeve – to demonstrate the effect of the ridges in the flue on 3D printed components.

Breath Flute #37

Another print of the #36 design (with the concave top of the sound chamber). However, it cleaved off at the lip / end of the flue when Vladimir was trying to fit an overly tight sleeve. Useful for a photograph of what the concave looks like and what the infill looks like in this area.

Ram Mallappa

In late January 2017, I contacted Ram Mallappa, who presented a session on his experiences with 3D printing Bansuri flutes at the World Flute Society convention the prior July in Eau Claire, Wisconsin. (I could not attend that presentation because of a schedule conflict at the convention.)

I found a video of his presentation at https://www.youtube.com/watch?v=wpTgwUVJ6hQ, and sent him an email asking for advice. A summary of his advice was:

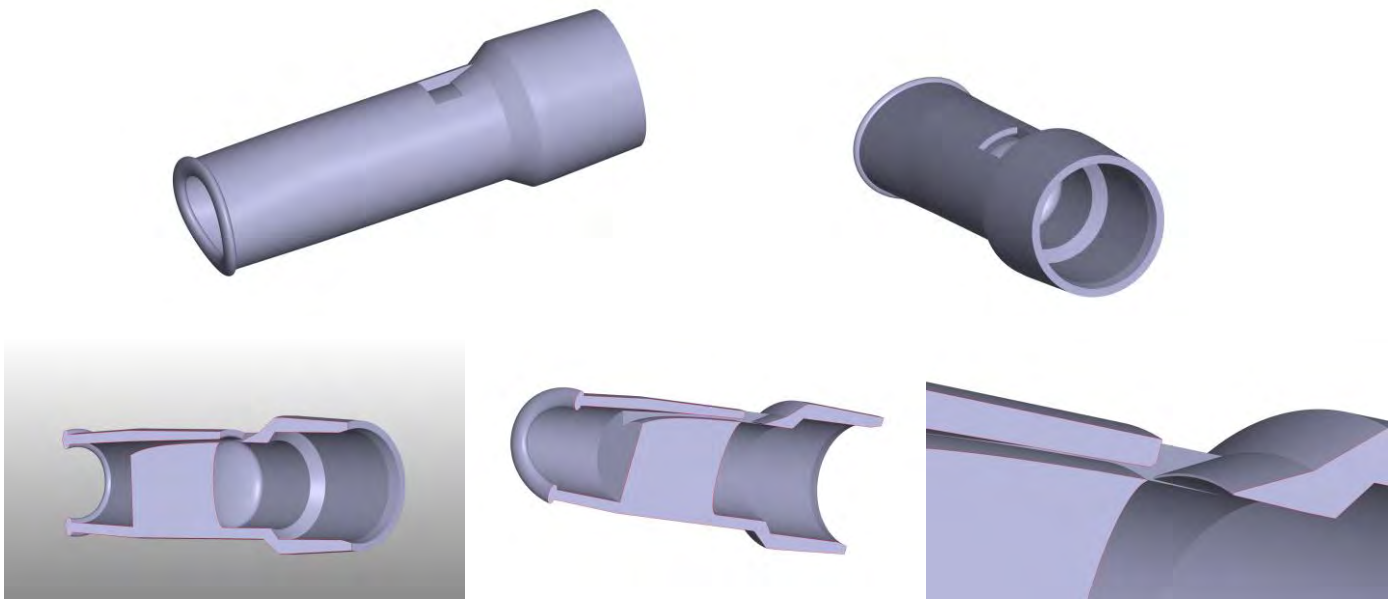
- Move design development from Fusion360 to OpenSCAD.
- Be very suspicious of sleeve designs, which he found to be *"very painful as dimensions do not come out exactly to have a snug fit"*.

OpenSCAD – the "40 Series"

On February 3, 2017 I began re-implementation of the design using OpenSCAD. Downloaded and installed the application with no problems and began model development. This begins the "40" series of Breath Flute prototypes.

Breath Flute #40

OpenSCAD design as of February 10, 2017 that I considered ready for printing (with caveats, of course). This design was not printed, but shared with Jon Norris and Vladimir Mariano for comment. Currently 2,800 lines of OpenSCAD code and extensive comments in `BFlute_040.scad` plus three OpenSCAD include files.



Design choices:

- open mouthed (preferred by the players at Flute Haven),
- a "lip ring" shape motivated by www.NuMouthpieces.com,
- an enclosed flue (rather than a sleeve design),
- an integral coupler to 1¼" PVC (like the Creo-designed fujara cap), and
- a curved splitting edge with a very slight lift

Worked a lot on flue shape. The source code has five flue shape choices. This version is based on Peter Riley's "gold standard" PVC fujara that I measured with feeler gauges (41 measurements). I'm also looking at low-range baroque recorders, and I'm coming to the conclusion that, unlike NAFs, the best choice for the breath flute is a "continuously focusing / compressing flue". There's no straight/flat section at the end. The sides of the flue continuously narrow (as with many NACA cowl designs), and the floor follows an arctangent curve all the way to the flue-exit.

Notice the "chamfer" on the upper exit of the flue. I added it as an optional feature - None, angled, or rounded. This one is rounded. There should be a lower chamfer, but it got chopped off by a last-minute addition of the backset – the rounded head of the sound chamber – which I added for printability – I don't think the printer can support a full-width flat bore head).

Dice

Printed one NAF Dice as a test in White PLA. Detail is not sufficient at the 16mm size to distinguish the finger diagram. Probably need at least 24mm dice and maybe print the finger diagram diagonally. Results:

- The fidelity of printing will not be anywhere near enough to print people's names

Breath Flute #41

The design was sliced in Cura to test-print just the critical section from the TSH on upwards, to test the challenges of the overhangs in this area.

- Printed: February 14, 2017
- Source: `BFlute_041.scad`
- STL: `BFlute_041_20170214_NoSupports_Valid_HiRes.stl` (43MB)
- G-code: `Clint41_BFCutTest.gcode` (16.5MB)
- Slicer: Cura 2.3.1 … to select the TSH area and up
  - Printer: Ultimaker 2+; Nozzle: 0.4mm; Material: PLA
  - Profile: Fast Print with all standard settings:
    - Layer Height: 0.15mm (150µm)
    - Wall Thickness: 0.7mm
    - Top/Bottom Thickness: 0.75mm
    - Infill Density: 18%
    - Enable Retraction: On
    - Print Speed: 60 mm/sec
    - Travel Speed: 150 mm/sec
    - Enable Print Cooling: On

    - Enable Support: Off
    - Build Plate Adhesion Type: Brim
    - Brim Width: 8.0mm
    - Print Sequence: All at Once
- Printer: UM2+/FCMG, 0.40mm brass E3D nozzle
- Filament: White PLA, 2.85mm
- Temperature: (not sure)

Results: Test showed significant issues with the existing overhangs … supports needed for these areas:

- Top of the dome
- Flue top edge
- Flue bottom edge – maybe make the lip of the "dome" at the top of the bore wider

Breath Flute #42

Test print using of the same specs as #41 to test a new filament:

- **Printed:** February 16, 2017
- **G-code:** `Clint41_BFCutTest.gcode` (Same G-code and Slicer settings as #41)
- Printer: UM2+/FCMG, 0.40mm brass E3D nozzle
- Filament: Entwined – Hemp Filament by 3D-Fuel, 2.85mm (http://www.3dfuel.com/shop/entwined-hemp-filament/) "Entwined prints well at 180-210 C."
- Temperature: 230°C … Vladimir suggested going hotter than recommended

Results:

- Slightly rougher than the White PLA.
- It also demonstrates the need to have an open flue – the flue will be too rough to be usable without sanding / post processing.
- The chamfers at the distal end of the flue cannot possibly be "Ellipse" – the angle is unsupported. Best to use "Straight" chamfers with an angle < 45°.

Breath Flute #43

Test print adding support structures (scaffolding) …

- **Printed:** February 16, 2017
- **Source:** `BFlute_041.scad`
- **STL:** `BFlute_041_20170214_NoSupports_Valid_HiRes.stl` (43MB)
- **G-code:** `Clint43_BFwSupp.gcode` (24.6MB)
- Slicer: Cura 2.3.1 … selected the very top of the splitting edge & up
  - Printer: Ultimaker 2+; Nozzle: 0.4mm; Material: PLA
  - Profile: Fast Print with all standard settings except:
    - Enable Support: **On**
    - Support Placement: **Everywhere**
- Printer: UM2+/FCMG, 0.40mm brass E3D nozzle
- Filament: Entwined – Hemp Filament by 3D-Fuel, 2.85mm
- Temperature: 230°C

Results: Support structures automatically generated by Cura are useless! However, the print gives a good guideline for support structure strategies that work: thickness of the vertical "wafers" and cross-hatching at the bottom.

Prototypes 44, 45, and 46 as they printed, with brims at the bottom for stability, before trimming.

Breath Flute #44

The first of the "split design" with separate bird and body components. Also:

- moved the dome of the sound chamber more off-center to give a bigger lip to the bottom of the flue,
- changed the flue chamfer to straight with a 27° angle, and
- drastically reduced the amount of lettering

Printed the bird portion in high quality:

- **Printed:** February 17, 2017
- **Source:** `BFlute_044.scad`
- **STL:** `BFlute_044_20170217_Bird_InValid_HiRes.stl` (381Kb)
- **G-code:** `Clint44_Bird_HiR_HiQ.gcode` (7.6MB)
- Slicer: Cura 2.3.1
  - Profile: High Quality with all standard settings except:
    - Layer Height: 0.06mm (60µm)
    - Wall Thickness: 1.05mm
    - Top/Bottom Thickness: 0.72mm
    - Infill Density: 12%
    - Enable Retraction: On
    - Print Speed: 50 mm/sec
    - Travel Speed: 120 mm/sec
    - Enable Print Cooling: On
    - Enable Support: Off
    - Build Plate Adhesion Type: Skirt
    - Brim Width: 8.0mm
    - Print Sequence: All at Once
- Printer: UM2+/FCMG, 0.40mm brass E3D nozzle
- Filament: Entwined – Hemp Filament by 3D-Fuel, 2.85mm
- Live settings:
  - Nozzle temperature: 230°C
  - Build time: 1:27:00

Prototype #44, after it cracked.

Results: Multiple bands of light-colored material, including one wide band of porous, very light, "shriveled" material. Cracked as soon as I took it off the printer. Looks like the Hemp ain't gonna cut it!

Breath Flute #45

Print identical to #44 – High Quality with standard settings, but with:

- Filament: Ultimaker PLA Black, 2.85mm, 195–240°C, Tape or 60°C Glass, UM-9014.
- Live settings:
  - Nozzle temperature: 220°C
  - Build time: 1:27:00

Prototypes 45 and 46, after trimming.

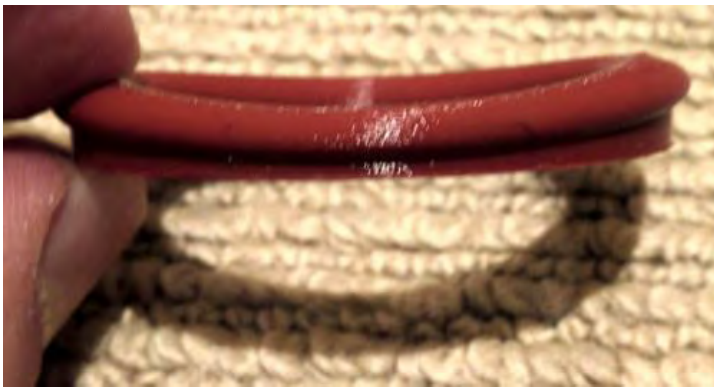
Results: Smooth and even … excellent!

Breath Flute #46

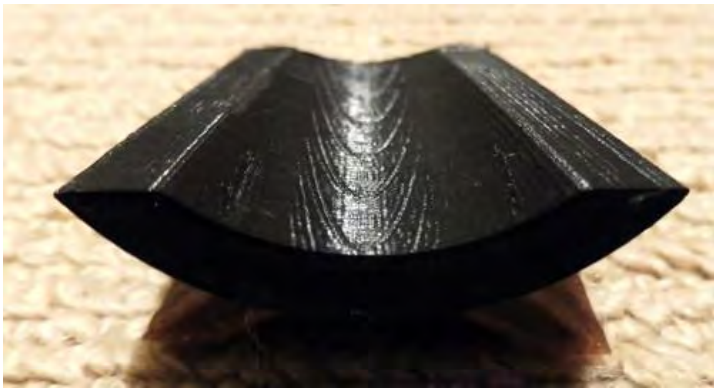
Sliced the very top of the lip plate off in Cura for printing in Clay Red PLA with Normal Printing settings:

- Printed: February 17, 2017
- Source: `BFlute_044.scad`
- STL: `BFlute_044_20170217_Body_Valid_HiRes.stl` (39.5MB)
- G-code: `Clint44_Mouth_HiR_NormQ.gcode` (3.4MB)
- Slicer: Cura 2.3.1
  - Printer: Ultimaker 2+; Nozzle: 0.4mm; Material: PLA
  - Profile: Normal Quality with all standard settings except:
    - Layer Height: 0.1mm (100µm)
    - Wall Thickness: 1.05mm
    - Top/Bottom Thickness: 0.8mm
    - Infill Density: 20%
    - Enable Retraction: On
    - Print Speed: 50 mm/sec
    - Travel Speed: 120 mm/sec
    - Enable Print Cooling: On
    - Enable Support: Off
    - Build Plate Adhesion Type: Brim
    - Brim Width: 8.0mm
    - Print Sequence: All at Once
- Printer: UM2+/FCMG, 0.40mm brass E3D nozzle
- Filament: ProSpec PLA. Advance Ingeo PLA for Professional 3D Printing, Print Temp 200C – 230C, Anneal Temp: 80°C-130°C, Heated Bed: None Clay Red 2.85mm, by ProtoParadigm.
- Live settings:
  - Nozzle temperature: 220°C
  - Build time: 0:57:00

Results: Smooth and even … excellent!



Edge of #46



Bottom of #45

Predicted times for just the top lip:

- Fast Print (150µm): 0:25
- Normal Quality (100µm): 0:51
- High Quality (60µm): 1:20

Predicted times for the full body (HiRes STL):

- Fast Print (150µm): 6:04
- Normal Quality (100µm): 13:33
- High Quality (60µm): 22:57

Predicted times for the full body (LowRes STL):

- Fast Print (150µm): 6:04
- Normal Quality (100µm): 13:33
- High Quality (60µm): 22:56

Thin-Wall Vase Construction

On March 25, 2017 I participated in an open house at the Fairfield County Makers' Guild, and saw a thin-wall (vase construction) "Spiral Sleeve and Insert" project of Vladimir's. It highlighted the speed of construction of a thin-wall design.

This also allows sanding of the flue area. However, it does not solve the support issue for the face of the block/bird. It also ignores the advice of Ram Mallappa to be suspicious of two-part designs requiring a snug fit.

Two Vase Construction models of Vladimir

Sleeve / Insert Designs – the "50 Series"

#50 Insert

On April 17-18, 2017 I re-designed the headjoint into a two-component design consisting of:

`Sleeve` – the "main" component of the headjoint, containing the TSH and mortice sections

`Insert` – which inserts into the `Sleeve` and contains the floor of the flue, the wall at the head of the sound chamber, and the lip plate.

Ultimaker 2+ Media is: microSD microSDHC Adapter by Sandisk.

Breath Flute #50 – Insert

Printed in Black PLA with Normal Printing settings:

- Printed: April 18, 2017, 9AM
- Source: `BFlute_050.scad`
- STL: `BFlute_050_20170417a_Insert_Valid_HiRes.stl` (30.5 MB)
- G-code: `Clint50_Insert_HiR_NormQ_UM2.gcode` (20.3 MB)
- Slicer: Cura 2.3.1
  - Printer: Ultimaker 2+; Nozzle: 0.4mm; Material: PLA
  - Profile: Normal Quality with all standard settings except:
    - Layer Height: 0.1mm (100µm)
    - Wall Thickness: 1.05mm
    - Top/Bottom Thickness: 0.8mm
    - Infill Density: 20%
    - Enable Retraction: On
    - Print Speed: 50 mm/sec
    - Travel Speed: 120 mm/sec
    - Enable Print Cooling: On
    - Enable Support: Off
    - Build Plate Adhesion Type: Brim
    - Brim Width: 8.0mm
    - Print Sequence: All at Once

#50 Insert

#50 Insert

- Predicted times (HiRes STL):
  - Fast Print (150µm): 1:23
  - Normal Quality (100µm): 2:43
  - High Quality (60µm): 4:27
- Printer: UM2+/FCMG, 0.40mm brass E3D nozzle
- Filament: Ultimaker PLA Black, 2.85mm, 195–240°C, Tape or 60°C Glass, UM-9014.

- Live settings:
  - Nozzle temperature: 220°C
  - Speed: 100%
  - Buildplate temperature: 70°C
  - Material Flow: 100%

Initially, the brim curled up a bit on the inside near the edge of the component as it was being printed.

The base, 0.5 mm thick by design, seemed to print in 3 layers.

The walls seem to call for two passes of the nozzle.

The sides of the flue are absent/incomplete near the proximal end! Looking carefully at those flue walls, they are thinner near the radial center than they are near the outer shell of the insert component. They are likely "too small" to print!

Print started at 9:00AM. Lip began printing at 11:04, end at 12:46

Build time: 2:46:00

Results: Smooth and even … excellent!

TBD on the Insert component: *Markings in Green indicate things fixed for #51*

- The walls seem to call for two passes of the nozzle. *DONE – made thinner – to 0.4 to match the nozzle.*
- The sides of the flue are absent/incomplete near the proximal end! Looking carefully at those flue walls, they are thinner near the radial center than they are near the outer shell of the insert component. They are likely "too small" to print! *DONE – made thicker*
- The foot of the Insert is porus! Not solid at all. Looks like 3 layers of infill. Not sure why. *DONE – made the floor thicker?*
- Change the shape of the proximal end of the flue on the outside, which is a straight, unsupported overhang. *DONE – added a "V" notch*
- Extend the leading edge of the flue across the entire component in a max 45° slope to (mostly) close off the chamber below the flue. Leave a small hole for access. This will strengthen the entire component, create a smoother airflow into the flue, and maybe make an area that could be filled with epoxy for strength. *DONE – new complex shape!*
- Make the lip smaller – it's more aesthetic, a wide lip is not really helpful, and faster build time. *DONE*
- Provide a small triangular support on the underside of the lip on the inside only. *DONE – complex lip shape re-forming stuff.*

Breath Flute #50 – Sleeve

Printed in Black PLA with Normal Printing settings:

- **Printed:** April 18, 2017

- Source: `BFlute_050.scad`
- STL: `BFlute_050_20170418a_Sleeve_Valid_HiRes.stl` (2.8 MB)
- G-code: `Clint50_Sleeve_HiR_NormQ_UM2.gcode` (51.0 MB)
- Slicer: Cura 2.3.1
  - Printer: Ultimaker 2+; Nozzle: 0.4mm; Material: PLA
  - Profile: Normal Quality with all standard settings except:
    - Layer Height: 0.1mm (100µm)
    - Wall Thickness: 1.05mm
    - Top/Bottom Thickness: 0.8mm
    - Infill Density: 20%
    - Enable Retraction: On
    - Print Speed: 50 mm/sec
    - Travel Speed: 120 mm/sec
    - Enable Print Cooling: On
    - Enable Support: Off
    - Build Plate Adhesion Type: Brim
    - Brim Width: 8.0mm
    - Print Sequence: All at Once
- Predicted times for the `Sleeve` (HiRes STL):
  - Fast Print (150µm): 3:56
  - Normal Quality (100µm): 8:38
  - High Quality (60µm): 14:27
- Printer: UM2+/FCMG, 0.40mm brass E3D nozzle
- Filament: Ultimaker PLA Black, 2.85mm, 195–240°C, Tape or 60°C Glass, UM-9014.
- Live settings:
  - Nozzle temperature: 220°C
  - Speed: 100%
  - Buildplate temperature: 70°C
  - Material Flow: 100%

#50 Sleeve

Print started at 11:57AM. Left to print on its own.

Build time: Unknown.

Print Results: Smooth and even … excellent!

TBD on the `Sleeve` component:

- extend the proximal end of the bird all the way down into the body
- Add a ?curve? to the face of the bird to deal with the straight overhang

#50 Sleeve

Printing:

- Maybe a brim is not needed?? It is useful at least for prying up the part, but maybe not so useful for stability … However, it does handle priming the system (nozzle extrusion issues when it starts up). Maybe a brim of ½ the size? Or maybe a skirt??

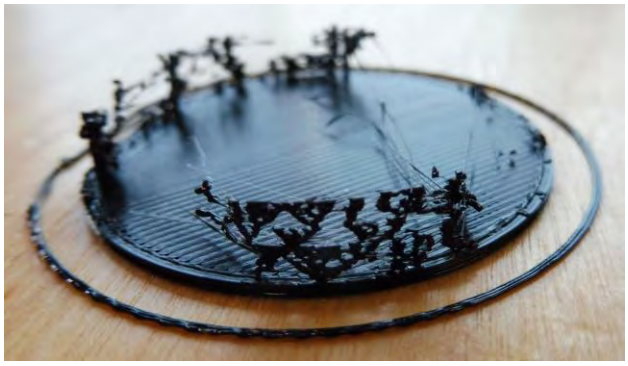
Good name, from a spool of EcoMax PLA: EcoMax PLA Biopolymer.

Results on putting the two halves of #50 together (On Wed Apr 19 at 7AM): No so great. Strings at the top of the bird had to be filed down. Then the base of the insert leaks horribly. Then the top of the `sleeve` needed to be fit to accommodate the insert (it was too tall), then the insert was a bit wishy washy rotationally – there is no positive alignment feature. It did produce a wisp of a whistle, but just barely.

Breath Flute #51 – Insert

Printed in Black PLA with Normal Printing settings:

- Printed: April 19, 2017, 9AM
- Source: `BFlute_051.scad`
- STL: `BFlute_051_20170419a_Insert_Valid_HiRes.stl` (30.9 MB)
- G-code: `Clint51_Insert_HiR_NormQ_UM2.gcode` (11.7 MB) (a ***lot*** smaller than #50)
- Slicer: Cura 2.3.1
  - Printer: Ultimaker 2+; Nozzle: 0.4mm; Material: PLA
  - Profile: Normal Quality with settings:
    - Layer Height: 0.1mm (100µm)
    - Wall Thickness: 1.05mm
    - Top/Bottom Thickness: 0.8mm
    - Infill Density: 20%
    - Enable Retraction: On
    - Print Speed: 50 mm/sec
    - Travel Speed: 120 mm/sec
    - Enable Print Cooling: On
    - Enable Support: Off
    - Build Plate Adhesion Type: Skirt
    - Print Sequence: All at Once



- Predicted times (HiRes STL):
  - Fast Print (150µm): 1:32
  - Normal Quality (100µm): 2:33
  - High Quality (60µm): 4:05
- Printer: UM2+/FCMG, 0.40mm brass E3D nozzle
- Filament: Ultimaker PLA Black, 2.85mm, 195–240°C, Tape or 60°C Glass, UM-9014.
- Live settings:
  - Nozzle temperature: 220°C
  - Speed: 100%
  - Buildplate temperature: 70°C
  - Material Flow: 100%

Print started at 7:30AM.

Unaccountably disastrous print run. After printing a porous base area (again!) it proceeded to thrash about building up small "pylons" for the sides. Print aborted.

Maybe it was the print wall thickness, reduced from 5 to 4 mm?? *YES … anything even a hair less then 4mm will not print, so the "pylons" are those small parts that are 4mm.*

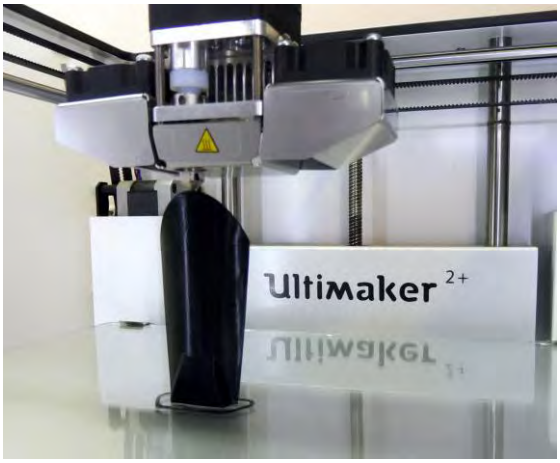
Results: Disaster

This, combined with the non-playability of the two-part `Sleeve`/`Insert` design, makes me think of abandoning this in favor of the `Body`/`Bird` design.

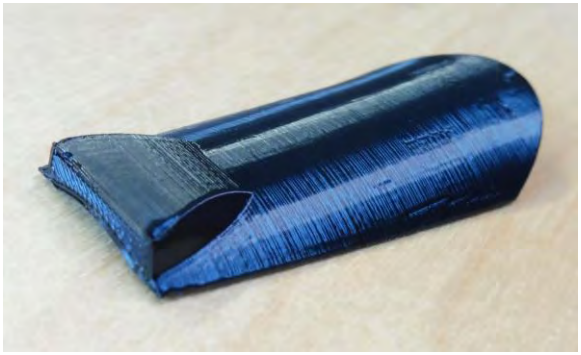
Breath Flute #52 – Bird

Printed in Black PLA with Normal Printing settings:

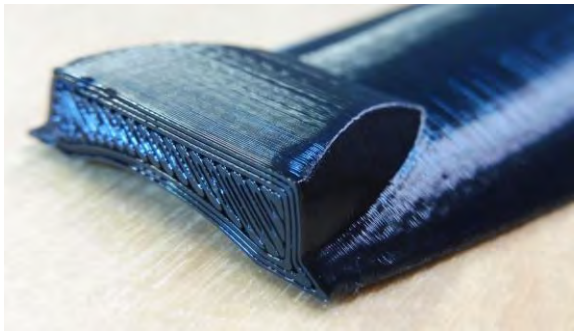
- Printed: April 19, 2017, 8AM
- Source: `BFlute_052.scad`
- STL: `BFlute_052_20170419b_Bird_Valid_HiRes.stl` (490 KB)
- G-code: `Clint52_Bird_HiR_NormQ_UM2.gcode` (5.4 MB)



- Slicer: Cura 2.3.1
  - Printer: Ultimaker 2+; Nozzle: 0.4mm; Material: PLA
  - Profile: Normal Quality with settings:
    - Layer Height: 0.1mm (100µm)
    - Wall Thickness: 1.05mm
    - Top/Bottom Thickness: 0.8mm
    - Infill Density: 20%
    - Enable Retraction: On
    - Print Speed: 50 mm/sec
    - Travel Speed: 120 mm/sec
    - Enable Print Cooling: On
    - Enable Support: Off
    - Build Plate Adhesion Type: Skirt
    - Print Sequence: All at Once



- Predicted times (HiRes STL):
  - Fast Print (150µm): 0:40
  - Normal Quality (100µm): 1:05
  - High Quality (60µm): 1:51
- Printer: UM2+/FCMG, 0.40mm brass E3D nozzle
- Filament: Ultimaker PLA Black, 2.85mm, 195–240°C, Tape or 60°C Glass, UM-9014.
- Live settings:
  - Nozzle temperature: 220°C
  - Speed: 100%
  - Buildplate temperature: 70°C
  - Material Flow: 100%



Print started at 8:10AM, finished 9:15 AM

Consider printing the Bird with 100% Infill … The build time reported by Cura with Normal Quality goes from 1:06 (20% Infill) to 2:01 (100% Infill).

Build time: 1:05:00

Results: Gorgeous

Breath Flute #52 – Body

Printed in Black PLA with Normal Printing settings:

- Printed: April 19, 2017, 9:30AM – left printing on its own …
- Source: `BFlute_052.scad`
- STL: `BFlute_052_20170419b_Body_Valid_HiRes.stl` (38.7 MB)
- G-code: `Clint52_Body_HiR_NormQ_UM2.gcode` (59.2 MB)
- Slicer: Cura 2.3.1
  - Printer: Ultimaker 2+; Nozzle: 0.4mm; Material: PLA
  - Profile: Normal Quality with settings:
    - Layer Height: 0.1mm (100µm)
    - Wall Thickness: 1.05mm
    - Top/Bottom Thickness: 0.8mm
    - Infill Density: 20%
    - Enable Retraction: On
    - Print Speed: 50 mm/sec
    - Travel Speed: 120 mm/sec
    - Enable Print Cooling: On
    - Enable Support: Off
    - Build Plate Adhesion Type: Brim
    - Brim Width: 8.0 mm
    - Print Sequence: All at Once

- Predicted times (HiRes STL):
  - Fast Print (150µm): 6:05
  - Normal Quality (100µm): 13:35
  - High Quality (60µm): 23:00
- Printer: UM2+/FCMG, 0.40mm brass E3D nozzle
- Filament: Ultimaker PLA Black, 2.85mm, 195–240°C, Tape or 60°C Glass, UM-9014.
- Live settings:
  - Nozzle temperature: 220°C
  - Speed: 100%
  - Buildplate temperature: 70°C
  - Material Flow: 100%

Print started at 9:30AM. Build time: Unknown – printed on its own.

Results: First working Breath Flute that was fully 3D printed … *Excellent!* Thoughts / observations:

- Something to “messed up” on the sides of the lip – did not observe the print and neither Mark nor Vladimir could offer a sound explanation.
- Entire headjoint is solid and sturdy.
- Sound quality is maybe a B or B– very good, but room for improvement. However, this is with no post-processing (sanding).
- Back pressure is a bit low, and it takes quite a bit of air.
- Might be some air leaking around the bird.

#52 Assembled Headjoint

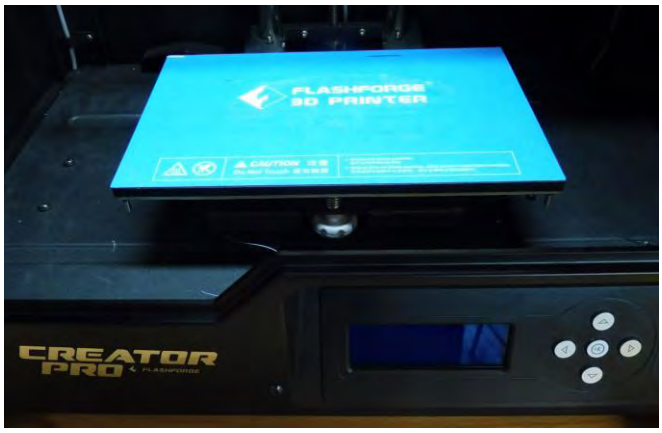
It is clear that the Body/Bird approach is better than the `Sleeve`/`Insert` approach.

Breath Flute #53 – Body and Bird

Significant design work done on April 20, 2017. Incorporated all design improvements from the `Sleeve` / `Insert` approach (`BFlute_052_InsertComponent.scad`) into `BFlute_053.scad`. This was a ***significant*** overhaul and upgrade of the code.

The `Body` was rendered but not printed. (The Ultimaker printer was busy at the FCMG, and I could not get a slicer that would work with the FlashForge Creator Pro). Predicted build time decreased from 13:35 to 12:23.

- Printed: April 20, 2017, 1PM
- Source: `BFlute_053.scad`
- STL: `BFlute_053_20170420_Body_Valid_HiRes.stl` (26.7 MB)
- G-code: `Clint53_Body_HiR_NormQ_UM2.gcode` (64.8 MB)
- Slicer: Cura 2.3.1 →
  - Printer: Ultimaker 2+; Nozzle: 0.4mm; Material: PLA Profile: Normal Quality
  - Print Setup [Custom]
    - Quality
      - Layer Height: 0.1mm (100µm)
    - Shell
      - Wall Thickness: 1.2mm (default was 1.05)
      - Top/Bottom Thickness: 0.8mm (why is this not working??)
      - Top/Bottom Pattern: Lines
    - Infill
      - Infill Density: 20%
    - Material
      - Enable Retraction: On
    - Speed
      - Print Speed: 50 mm/sec
      - Travel Speed: 120 mm/sec
    - Cooling
      - Enable Print Cooling: On
    - Support
      - Enable Support: Off
    - Build Plate Adhesion
      - Build Plate Adhesion Type: Skirt
    - Special Modes
      - Print Sequence: All at Once



- Predicted times for the `Sleeve` (HiRes STL):
  - Fast Print (150µm):
  - Normal Quality (100µm): 12:23 (vs. 13:35 for v52)
  - High Quality (60µm):
- Not Printed

At the FCMG, Vladimir suggested trying the Cura settings: Line Width to 0.48 or 0.40 to get full infill on the bottom layers. Or maybe try Top/Bottom pattern to "concentric" rather than "line".

Breath Flute #54 – Bird

Switched to Simplify3D 3.1.1 for a slicer. Printed in White PLA with S3D's High Print settings (analogous to Cura's Normal):

- Printed: April 21, 2017
- Source: `BFlute_054.scad`
- STL: `BFlute_054_20170421_Bird_Valid_HiRes.stl` (518 KB)
- Factory:
- Profile:
- G-code: `Clint54_Bird_HiR_S3D_HiQ_UM2.gcode` (3.0 MB)
- Slicer: Simplify3D 3.1.1 →
  - Printer: Ultimaker 2+, Nozzle: 0.4mm; Material: PLA
  - Profile: UM2+ Bird, Auto-Config: PLA / High qual:
    - Layer Height: 0.1mm (100µm)
- Predicted times (HiRes STL):
  - 100µm: 2:31 (Cura 2.3.1 reports 1:01!!) (this is likely because Simplify3D uses minimum layer print times to allow for cooling)
- Printer: UM2+/FCMG, 0.40mm brass E3D nozzle
- Filament: YS PLA White, 2.85mm, 190–240°C, Tape or 60°C Glass, UM-9014.
- Live settings:
  - Nozzle temperature: 220°C
  - Speed: 100%
  - Buildplate temperature: 70°C
  - Material Flow: 100%

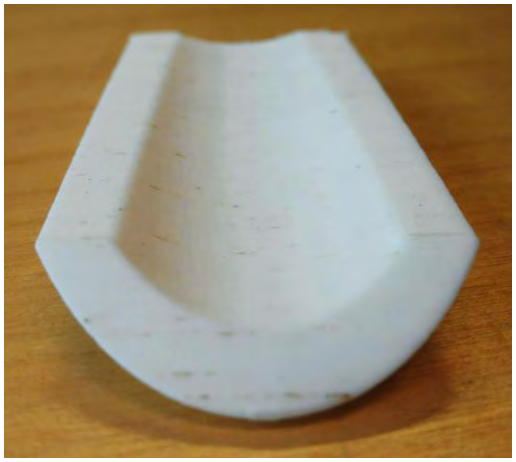
Print started at 12:33 PM, finished 3:11 PM

Printed 2 brim layers … don't really need two. This is a big problem, because the two layer Brim could not be cleanly removed, and it masked the top chamfer on the flue (leading edge of the bottom of the bird! Had to file away at the remaining brim and it did not come out cleanly …

Print proceeded ***ponderously*** slowly … more than twice the build time of the v52 bird using Cura. Need to compare all default settings of Cura and Simplify3D for the Ultimaker 2+.

Build time: 2:38:00

Results: Gorgeous



Breath Flute #54 – Bird on FlashForge Creator Pro

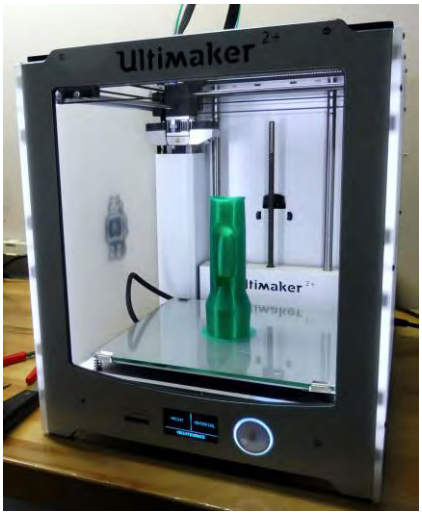
Attempted to print on FlashForge Creator Pro in Metalic Gold PLA with S3D's Medium Print settings:

- **Printed:** April 21, 2017
- **Source:** `BFlute_054.scad`
- **STL:** `BFlute_054_20170421_Bird_Valid_HiRes.stl` (518 KB)
- **Factory:**
- **Profile:**
- **G-code:** `C54_Bird_HiR_S3D_MQ_FFCP.x3g` (1.5 MB)
- `C54_Bird_HiR_S3D_MQ_FFCP.gcode` (1.3 MB)
- Slicer: Simplify3D 3.1.1 →
  - Printer: FlashForge Creator Pro, Nozzle: 0.4mm; Material: PLA
  - Profile: FFCP, Auto-Config: PLA / Medium qual:
    - Layer Height: 0.2mm (200µm)
- Predicted times (HiRes STL):
  - S3D HiRes STL @ LayerHeight = 200µm: 1:16
- Printer: FFCP/FCMG, 0.40mm brass E3D nozzle
- Filament: EcoMax Metalic Gold PLA, 1.75mm, 190–240°C.
- Live settings:
  - Nozzle temperature: 220°C
  - Speed: 100%
  - Buildplate temperature: 70°C
  - Material Flow: 100%

Print started at 1:00PM … BUT …

Could not get the extruder to come up to temperature. It works with preheat, but NOT when printing a model. Sigh.

Breath Flute #54 – Body



Printed in Translucent Green PLA with Normal Printing settings:

- Printed: April 21, 2017 – left printing on its own …
- Source: `BFlute_054.scad`
- STL: `BFlute_054_20170421_Body_Valid_HiRes.stl` (29.5 MB)
- Factory:
- Profile:
- G-code: `Clint54_Body_HiR_S3D_HiQ_UM2.gcode` (32.6 MB)
- Slicer: Simplify3D 3.1.1 →
  - Printer: Ultimaker 2+, Nozzle: 0.4mm; Material: PLA
  - Profile: UM2+ Bird, Auto-Config: PLA / High qual:
    - Layer Height: 0.1mm (100µm)
- Predicted times (HiRes STL):
  - S3D on HiRes STL @ 100µm: 9:57
  - Cura 2.3.1 HiRes STL @ 100 microns reports: 12:12, down from 13:35 in v52)
- Printer: UM2+/FCMG, 0.40mm brass E3D nozzle
- Filament: Ultimaker PLA Silver Metallic, 2.85mm, 195–240°C, Tape or 60°C Glass, UM-1612. … Could not get this material to load! Switched to a Maker Series Translucent Green material by MakerGeeks.
- Live settings:
  - Nozzle temperature: 220°C
  - Speed: 100%
  - Buildplate temperature: 70°C
  - Material Flow: 100%

Print started at 3:50PM … Reported a 23-hour print time as of 4:05PM.

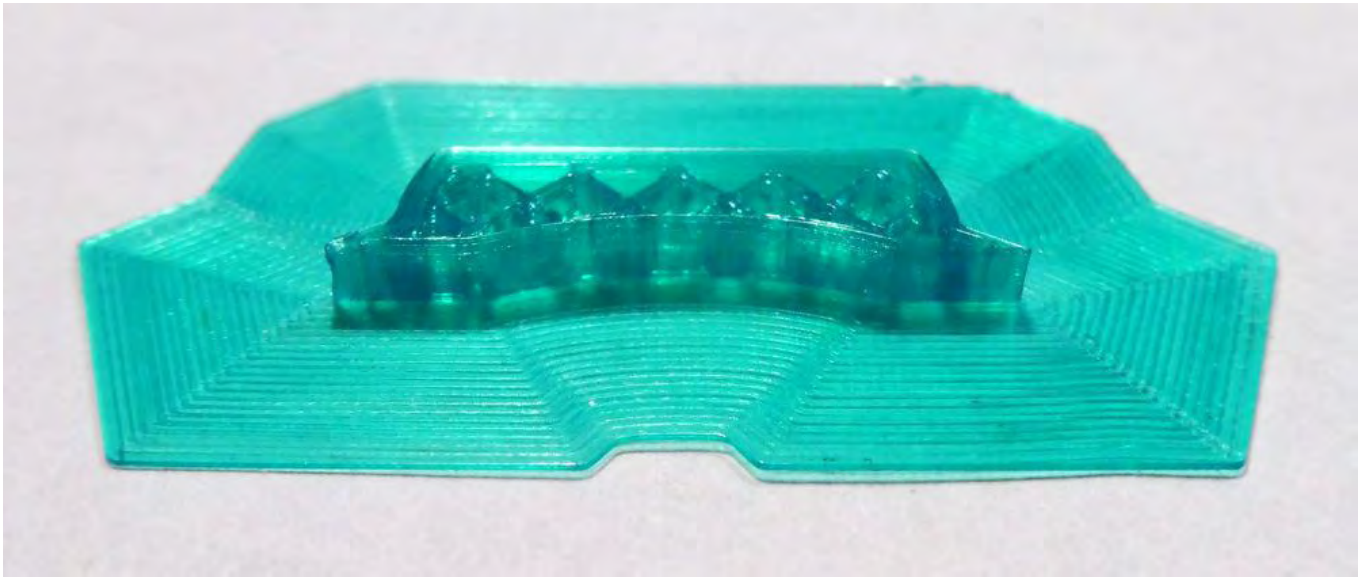
Build time: Unknown – printed on its own – but picked it up a 9AM on April 22, 2017, so less than 17 hours.

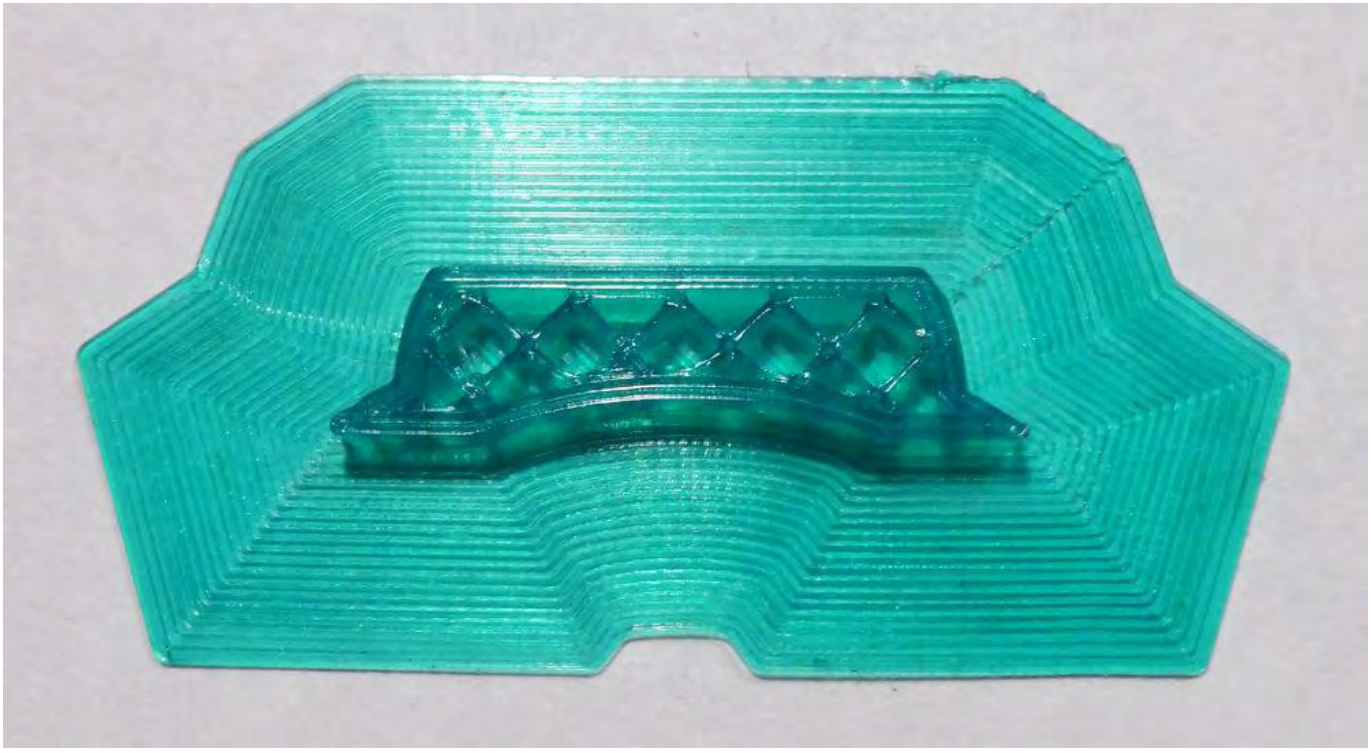
Results: Some "stringing" of the material – easily removed.

Breath Flute #55 – Bird Fragment

Fragment of the #54 Bird printed as a demo for Vasken Kalayjian on the Ultimaker 2+ in Translucent Green PLA.

Kept this as a good example of what the infill looks like:





Ideas and Research While on the Road

This section has ideas from before and during the Asia road trip, dated 4/24/2017 through 5/23/2017. They were initially entered into `TBD.txt`, then copied here on 5/19 & 23/2017. Items in Green were implemented in the Version 60 series starting 6/26/2017.

From before the start of the trip (on 5/2/2017):

- Maybe a hole in the Ramp component? Filled with epoxy?
- Tools to ream out the inside to smoothness
- Sand down the prototypes!
- Print ID, Version, and date info onto the angled Ramp.
- Slicer Settings document
- Print Body and Bird in same print, side by side, with the bird rotated 90° and fit tight to the body to reduce travel. This will have the added advantage of speeding up the bird print, since Simplify3D is slowing down the print because layer print times are small and it is waiting for additional time to cool (I think).
- Test components in alcohol
- Test components in dishwasher
- Modify design so Bird does not slide around so much.
- Shorten flue?
- Go back to flare out to lip plate – more aesthetic, less association with condoms! – Done 6/26/2017.
- Shorten MorticeLength from the v54 of 40mm to the tested max insertion depth for the v52 and v54 models of 25mm. (The black v52 was 25mm and the green v52 was 22mm). Hopefully this will be sturdy enough!
- The middle bevel - the one that is horizontal - is barely visible ... make it more pronounced?
- Change the mortice bevel angle to something like 35°, which seems to work AOK for the ramp!
- Print a version of the body sliced off at TSHProxStation-3mm up to TSHProxStation+5mm - or maybe up to the top of the Cone - or maybe not - to see clearly how the lower lip of the distal end of the flue is supported.
- Print a version that shows the leading edge of the splitting – go from TSHDistStatopm-3mm up to TSHDistStation+3mm.
- Consider a gasket to seal the Bird on the Body. Maybe a 3D printed one (!) made of some pliable material? Like one layer thick, in just the correct shape?

While on the Asia trip starting 5/2/2017:

- Add a light (LED) Inside the plug area!!
- A la lighted gloves; control the modes; remote control?; on-off switch; battery compartment; designed into the 3D print

- Maybe do post-production of the printed headjoint using the CNC milling machine.
- Cross-Breath Flute or Harmony Breath Flute - a "cross-flute" design with two sides to the headjoint taking two different diameter sound chambers and a T-shaped arrangement for the mouthpiece - giving a harmony flute with two different notes - fifth? Octave??
- Look into using Silicone for parts - like the lip. Saw Sipals.com products at the National Palace Museum in Taiwan – silicone teacups and placements and such. Have photo of the safety grid from Sipals.
- Treat lip of the breath flute with polyurethane spray or dip – is it safe?? (YES! See Lambert_2005_FoodSafeFinishes)

Ideas beginning 5/23/2017:

- Consider destructive testing of printed parts for strength
- Database tables of prototypes (Proto), prints (Renders), and Calibration measurements (Calib) to measure shrinkage or %variation in actual print sizes to designed parameters.

Filament Research

Extensive research done 5/10–18/2017 on filaments, logged in the greatly expanded `3D_Printing.xlsx`

Decided that the ideal filament was ColorFabb nGen clear (http://colorfabb.com/ngen-clear).

nGen Positive attributes:

- FDA approved for food contact.
- No coloration that might be potentially toxic.

nGen Negatives:

- Not biodegradable

General-audience description of items printed with ColorFabb nGen filament (note that it is not biodegradable and does not appear to be recyclable – if it were, we could add "that is biodegradable/recyclable and …" in the first sentence):

> Breath flutes are made from a food-grade, styrene-free, organic polymer that is FDA-approved for food contact. It can be cleaned in alcohol, and we routinely immerse the Breath Flutes we use at workshop in 95% grain alcohol (190-proof EverClear™) or 80-proof Vodka. They withstand high temperatures (above 180°F), so they can be sent through a dishwasher cycle, even commercial-grade dishwashers with a high-temperature sanitization rinse cycle.

Alternate general-audience description of items printed with MakerGeeks Raptor PLA filament:

Breath flutes are made from a food-grade, styrene(??) and BPA-free, bio-polymer that is biodegradable and FDA approved for food contact. It can be cleaned in alcohol, and we routinely immerse the Breath Flutes we use at workshop in 95% grain alcohol (190-proof EverClear™) or 80-proof Vodka. They withstand high temperatures (above 180°F) (??only for the annealed version??), so they can be sent through a dishwasher cycle, even commercial-grade dishwashers with a high-temperature sanitization rinse cycle.

See Refs/RecipeMarketing_2011_PLAvsPS for a good description!

Polylactic acid (PLA), a plastic substitute made from fermented plant starch (usually corn) is quickly becoming a popular alternative to traditional petroleum-based plastics. As more and more countries and states follow the lead of China, Ireland, South Africa, Uganda and San Francisco in banning plastic grocery bags responsible for so much so-called “white pollution” around the world, PLA is poised to play a big role as a viable, biodegradable replacement. Poly(lactic acid) or polylactide (PLA) is a thermoplastic aliphatic polyester derived from renewable resources, such as corn starch (in the United States), tapioca products (roots, chips or starch mostly in Asia) or sugarcanes (in the rest of world). It can biodegrade under certain conditions, such as the presence of oxygen, and is difficult to recycle. PLA is used for biodegradable and compostable disposable cups for cold beverages, the lining in cups for hot beverages, deli containers and clamshells for food packaging.[12] Researchers have improved the glass transition temperature of PLA to use with hot liquids up to 110C (230F). [13]As of Jun 2010, NatureWorks was the primary producer of PLA (bioplastic) in the United States.4 PLA is BPI certified compostable.

PLA, or corn plastic, is made with Midwestern corn, not Middle East oil. Its production releases fewer toxic substances than making petroleum plastic and uses less energy, spewing an estimated two-thirds less greenhouse gas. And corn plastic can be composted, incinerated or recycled, its manufacturer says, offering "the most alternatives" of any plastic to landfilling.5

The trendy plastic has several things going for it. It’s made from a renewable resource, which means it has a big leg up—both politically and environmentally—on conventional plastic packaging, which uses an estimated 200,000 barrels of oil a day in the United States. Also, PLA is in principle compostable, meaning that it will break down under certain conditions into harmless natural compounds. That could take pressure off the nation’s mounting landfills, since plastics already take up 25 percent of dumps by volume. And corn-based plastics are starting to look cheap, now that oil prices are so high.

For retailers, PLA has a halo effect. Wild Oats was an early adopter of the stuff. “Our employees loved the environmental message of the containers, that they came from a renewable resource, and our customers had a strong reaction when we told them they were compostable,” says Sonja Tuitele, a Wild Oats spokesperson. The containers initially boosted the company’s deli sales by 17 percent, she says, and the chain now uses six million PLA

containers a year. Newman's Own Organics uses PLA packaging for its salad mixes. "We felt strongly that everywhere we can get out of petroleum products, we should," says Newman's Own CEO Peter Meehan. "No one has ever gone to war over corn."6

Summary: PLA is not perfect. One main issue with PLA is that, because it is of different origin than regular plastic, it must be kept separate when recycled, lest it contaminate the recycling stream. Being plant-based, PLA needs to head to a composting facility, not a recycling facility, per se, when it has out served its usefulness. And that points to another problem: There are currently only 113 industrial-grade composting facilities across the United States. Another downside of PLA is that it is typically made from genetically modified corn, at least in the United States. Learn about the global trends of GM crops at http://youtu.be/SYCdVEB0TPc.

PLA IS better, just not the best and final solution to replace petroleum-based plastics. Do the pros outweigh the cons? A unanimous yes. Considering that plastic has insinuated itself into just about every part of our lives from food packaging to clothing, using more environmentally friendly plastic is a vast improvement over the alternative. Since PLA or biopolymer plastic can be manufactured into just about every plastic item known to humankind, that alone makes it a winner.

Frank Scotti, Chief Idea Officer at Recipe Marketing, Food and Beverage Specialty Marketing Firm located in San Luis Obispo, CA

Additional info on the use of coloring:

> We use clear filament to avoid potentially toxic coloring additives, and for better control of the fabrication process.

See some of the Ultimaker filament TDS documents for examples of different specifications for transparent vs. colored filaments.

Guide to Printing with Amphora AM3300

Advice from the document: `Eastman_Amphora_PrintingGuide_SPMBS1803.pdf`

The following recommendations have been established for optimal Amphora AM3300 printing conditions.

Temperature: 220°–250°C. Start at 220°C and increase 5° until desired flow and proper layer adhesion are established. Different printers may require slightly different temperature settings.

Heated bed: 65°–85°C. Bed adhesion will be achieved when using a clear glass plate; however, there is a risk of pulling glass pieces from the build surface when using this method. Hair spray can be used to reduce the risk of the print adhering to the build bed.

Percent (%) flow: 90% –104%. Set first layer height at 150% with a width of 120% and 40% speed. Start the print with a skirt to ensure optimal filament flow through the nozzle.

Retraction distance: 3mm. Retraction distance varies from printer to printer. Use suggested retraction distance with a 0.3 mm coast and 0.3 mm vertical lift.

Retraction speed: 45 mm/sec. Experiment with your printer as necessary to determine optimal retraction settings.

Printing speed: 35–50 mm/sec. Do not print too fast. Allow the material time to effectively stick to the build plate and first layers.

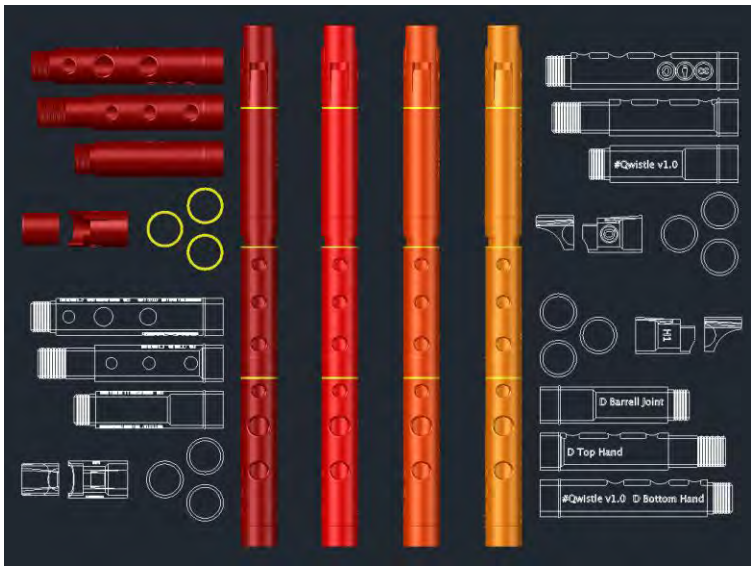
Layer height: 0.15-0.20mm on a 0.4mm nozzle. Monitor the first layer to make sure no material sticks to the nozzle and accumulates. If the first layer has no buildup or skips a layer the rest of the print should be successful.

Cooling fan: Engage in cooling at 60% after layer 4. This percent varies from printer to printer. Too much cooling combined with low print temperature and high print speed could result in layer delamination in prints.

Best bridging: 60 mm/sec with 100% cooling. Aim to run the fan at 100% rate during bridging operations when attempting to print overhangs or gaps without physical support. If bridging is done too quickly, melt break will occur. However, if done too slowly, layers will start sagging.

Finish: Cool bed to less than 40°C. Minimize print distortion and allow easier removal by cooling before attempting to remove the print from the bed.

QWistle



Came across the QWistle on 5/19–22/2017 (https://lindstruments.com/pages/the-qwistle), an open-source (CC-BY-SA, https://creativecommons.org/licenses/by-sa/3.0/) FFF design by Donald WG Lindsay (http://www.donaldwglindsay.com/).

Purchased it for £5 GBP (https://lindstruments.com/products/qwistle-printable-file-kit-stl-format) through PayPal. The project is in D:/BreathFlute/ThirdParty_Models/QWistle.

The date of the STL files in the purchased ZIP file are 5/29/2014. The ReadMe.rtf file in the purchased ZIP was last modified 7/2/2015.

The whole project was relocated to D:/BreathFlute/QWistle on 6/29/2017.

Epoxy Coatings

Met with Alex (alex@imakr.com) at the iMakr Store in New York City (152 Allen Street, New York, 10002, 212-477-1930) on June 21, 2017. He suggested, rather than spray polyurethane, spray coatings by XTC-3D.

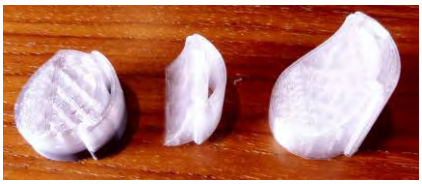
However …

See … `Lambert_2005_FoodSafeFinishes.docx`, `CFR_Title21_FoodAndDrugs_IndirectFoodAdditives`, and `PolyurethaneFoodContact_10355.pdf` …

Which imply the safety of Polyurethane, and it is a simple spray-on which does not require mixing. XTC-3D is mixed, brush-on only, and is an epoxy resin which does not necessarily have food-safe components.

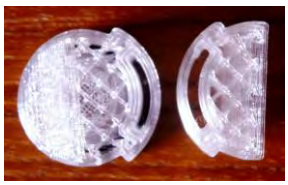
But need to find out … *What is the temperature resistance and other parameters for spray polyurethane??*

QWistle 001 – 6/27/2017 Test Print in nGen on FCMG Prusa i3 Mk2



First test print of the Scooped Windway component of the QWistle on 6/27/2017 on the new FCMG Prusa i3 MK2 printer, using ColorFabb nGen (Amphora 3300) filament.

Print started at 200°C on the Grey PLA that was in the printer, then switched to nGen 1.75mm filament in the middle, then raised temperature to 220°C. Part broke in the middle when removed from the bed.



Two other print failures in nGen are not shown, including one accidentally at 200°C which slid off the bed in the middle:

- Printed: June 27, 2017 – about 30 minutes for each print.
- Source: *(STL files only)*
- STL: `Qwistle Scooped Windway.stl` (807 KB)
- Factory:
- Profile:
- G-code: `Qwistle_001_ScoopedWindway_Prusai3Mk2_S3dStd.gcode` (864 KB)

- Slicer: Simplify3D 3.1.1 →
  - Printer: Prusa i3 Mark2 (or maybe MK2S?), Nozzle: 0.4mm; Material: nGen
  - Profile: Prusa Research Original Prusa i3 MK2, Auto-Config: PLA / Medium qual:
    - Layer Height: 0.2mm (200µm)
- Printer: Pi3Mk2/FCMG, 0.40mm brass E3D nozzle
- Filament: ColorFabb nGen Clear, 1.75mm.
- Live settings:
  - Nozzle temperature: Failed at 220°C (part broke), success at 230°C
  - Speed: 100%
  - Buildplate temperature: 70°C
  - Material Flow: 100%
  - Build time: about 30 minutes.

Results: Good – part is a bit rough due to .2mm layer height.

Consolidated Design – the "60 Series"

On June 26, 2017, I incorporated many of the accumulated ideas into the headjoint, and began work with the new ColorFabb nGen (Amphora AM3300) filament and the new Prusa i3 Mark 2 printer. Incorporated ideas from **the Ideas and Research While on the Road** section above:

- Print ID, Version, and date info onto the angled Ramp – Done 6/27/2017.
- Print Lettering / Logo on the side of the outside of the headjoint – Done 6/28/2017.
- Print Body and Bird in same print, side by side, with the bird rotated 90° and fit tight to the body to reduce travel. This will have the added advantage of speeding up the bird print, since Simplify3D is slowing down the print because layer print times are small and it is waiting for additional time to cool (I think).
- Modify design so Bird does not slide around so much.
- Shorten ThroatLength (flue / throat) – shortened 6/28/2017 from 50mm to 38mm.
- Go back to flare out to lip plate – more aesthetic, less association with condoms! – Done 6/26/2017.
- Shorten MorticeLength from the v54 of 40mm to the tested max insertion depth for the v52 and v54 models of 25mm. (The black v52 was 25mm and the green v52 was 22mm). Hopefully this will be sturdy enough! – Done 6/28/2017.
- The middle bevel - the one that is horizontal - is barely visible ... make it more pronounced?
- Change the MorticeChamferAngle from (a hardwired) 45° to be a variable parameter and reduce it to 35°, which seems to work AOK for the ramp! – Done on 6/28/2017.
- Improve the handling of Ramp_Thickness by addition of a Ramp_ZOffset to better control the actual ramp thickness – Done on 6/29/2017.
- Print a version of the body sliced off at TSHProxStation-3mm up to TSHProxStation+5mm - or maybe up to the top of the Cone - or maybe not - to see clearly how the lower lip of the distal end of the flue is supported.

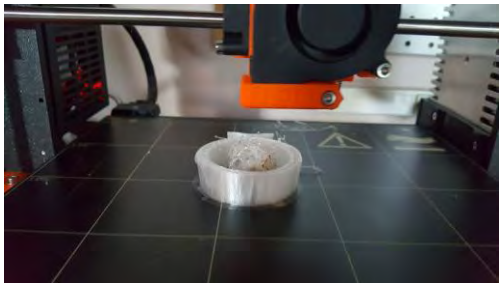
Breath Flute #60 – 7/1/2017 Body & Bird in nGen on FCMG Prusa i3 Mk2

Print of body and bird components in one print using ColorFabb nGen Clear on the Pi3Mk2/FCMG:

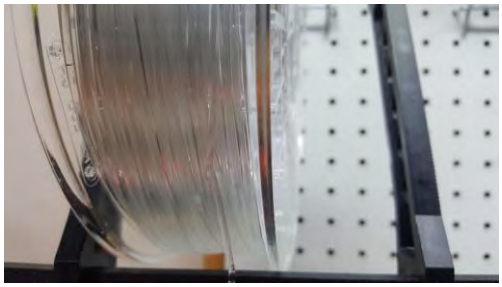
- Printed: June 1, 2017
- Source: `BFlute_060.scad`
- STL: `BFlute_060_20170630_Body_Valid_HiRes.stl` (30.4 MB)
- `BFlute_060_20170630_Bird_Valid_HiRes.stl` (516 KB)
- Factory: `BFlute_060_BodyBird_S3D_ Prusa_i3Mk2_20170630.factory`
- Profile: `BFlute FCMG Prusa i3Mk2 nGen 20170630.fff`
- Based on:
- G-code: `BFlute_060_BodyBird_S3D_Prusa_i3Mk2_20170630.gcode` (43.2 MB)
- Slicer: Simplify3D 3.1.1
  - Profile differences from `Prusa i3 Mk2 RC4 Prusa3Dcom Pristine 20170629.fff`:
    - Auto-Configure for Material: PLA (orig setting)

- Auto-Configure for Print Quality: DETAIL 0.1mm (orig setting)
- General Settings / Infill Percentage: 10% → 20%
- Primary Layer Height: 0.10mm (100µm) (orig setting)
- Skirt layers: 2 → 1
- Skirt Offset from Part: 1.80 → 0.00
- Skirt Outlines: 1 → 10
- Temperature / Primary Extruder T0: 1:215,2:200 → 1:230
- Temperature / Heated Build Platform T1: 1:55 → 1:70
- Avoid crossing outline for travel movements: OFF → ON

- Predicted build stats: Time: 11:06, Plastic weight: 73.77g (0.16 lb)
- Printer: Pi2Mk2/FCMG, 0.40mm brass E3D nozzle
- Filament: ColorFabb nGen Clear 1.75mm; Processing Temp: 220–240°C.
- Live settings:
  - Nozzle temperature: 230°C
  - Build plate temperature: 70°C

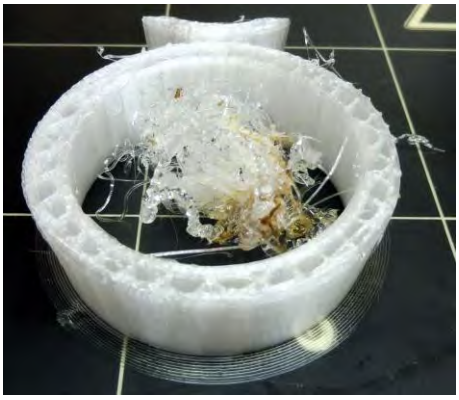


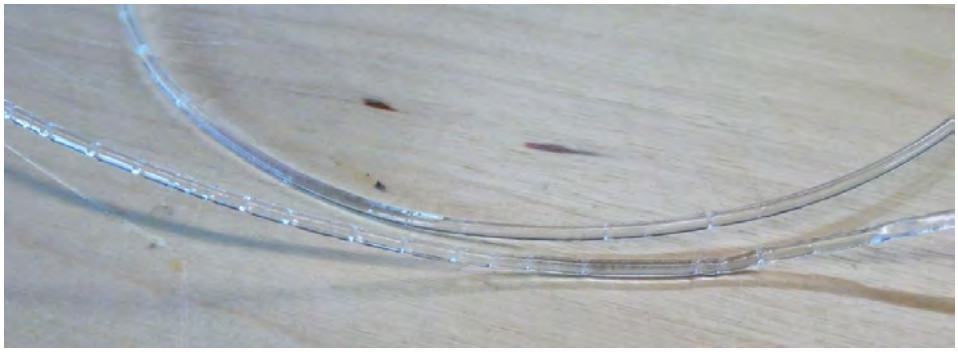
Print started at 6:30 AM. Failed sometime before Noon.



Results: Print failure reported by email from Vladimir at the club with pictures (shown at the right). The filament was tangled on the roll quite a ways down on the roll. Choked the print, burned the filament, and subsequently clogged the nozzle so badly I could not clear it after multiple load / unload cycles.

The images below are by Clint, showing the failed print and "bubbles" in the filament in the area that the roll was tangled. No idea what the bubbles are … a "splice" in the filament? Damage from having the roll pulled excessively by the printer trying to load the filament?





Thoughts: The portion of the foot of the headjoint that did print is telling. It has a very "plastic" feel to it … maybe not ideal for a Breath Flute. Compare it with the feel of the CorkFill that was used in the next print of the QWistle …

QWistle 002 – 7/1/2017 Full print in CorkFill on Ultimaker 2+

Print of all components in one print using ColorFabb CorkFill PLA on the UM2+/FCMG:

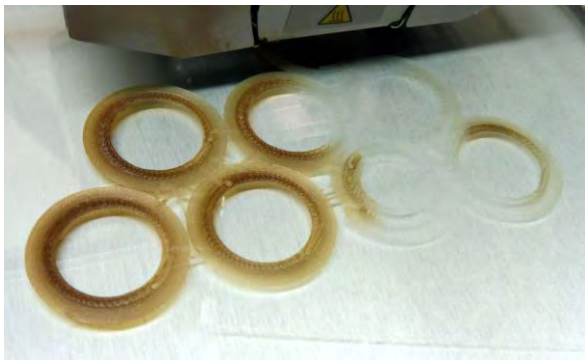
- **Printed:** July 1, 2017
- **Source:** *(STL files only)*
- **STL:** `Qwistle D Barrel.stl`
- `Qwistle D Bottom Hand.stl`
- `Qwistle D Top Hand.stl`
- `Qwistle H1 Fipple.stl`
- `Qwistle Ring Mounts.stl`
- `Qwistle Scooped Windway.stl` (807 KB)
- **Factory:** `Qwistle_002_AllParts_U2p_PLA_S3D_20170630.factory`
- **Profile:** `QWistle FCMG Ultimaker 2+ PLA` … saved as:
  `QWistle FCMG Ultimaker 2+ PLA as0f20170630_1626.fff`
- **Based on:**
- **G-code:** `Qwistle_002_AllParts_U2p_PLA_S3D_20170630.gcode` (54 MB)
- Slicer: Simplify3D 3.1.1
  - Profile differences from `Ultimaker 2+ S3D Pristine 20170630.fff`:
    - Auto-Configure for Material: ABS → PLA
    - Auto-Configure for Print Quality: Medium → High
    - General Settings / Infill Percentage: 30% → 100%
    - Primary Layer Height: 0.10mm (100µm) (orig setting)
    - Skirt layers: 2 → 1
    - Skirt Offset from Part: 4.00 → 0.00
    - Skirt Outlines: 2 → 6
    - Temperature / Primary Extruder T0: 1:205 → 1:220 (ColorFabb advises 210–230)
    - Temperature / Heated Build Platform T1: 1:60 (orig setting) (ColorFabb advises 50–60)
    - Default Printing Speed: 2500 mm/min (= 41.7 mm/sec) (ColorFabb advises 40–60 mm/sec). However, note that the default under-speed settings of 65% for outline and 70% for solid infill cause the actual print speed to be ***substantially*** slower than advised.
    - Avoid crossing outline for travel movements: OFF → ON
- Predicted build stats: Time: 9:45, Plastic weight: 54.84g (0.12 lb)
- Printer: UM2+/FCMG, 0.40mm brass E3D nozzle

- Filament: ColorFabb CorkFill 2.85mm; Processing Temp: 210–230°C.
- Live settings:
  - Nozzle temperature: 220°C
  - Build plate temperature: 60°C
  - Speed: 100%
  - Material Flow: 100%

Print started at 3:00 PM. Unknown finish time – print picked up at 5AM on 7/2/2017.

Results: Fantastic! Print appears perfect.

The beginning of the print showed unusual colorings. Notice that the left side of the print is the normal brown, by there is an area of very light, almost clear coloring on the right side.



QWistle was test-sanded and assembled around 7/15/2017. Installing the rings was made substantially easier using ¾" SDR9 PEX 5106 (160 PSI @ 73F) (Red) tubing to push the rings onto the tenons.

Sanding tests on Corkfill were no so encouraging. Sanding turns the surface white. Significant sanding with very fine grit emory does produce a nice shine, but I think it would be difficult to get the entire surface sanded, especially if there are corners or crannies that need sanding.

Breath Flute #60 – 7/2/2017 Body & Bird in CorkFill on Ultimaker 2+

Print of body and bird components in one print using ColorFabb CorkFill (PLA/PHA 70%, Cork 30%) on the FCMG Ultimaker 2+ using 100µm Layers and 30% infill.

- Printed: July 2, 2017
- Source: `BFlute_060.scad`
- STL: `BFlute_060_20170630_Body_Valid_HiRes.stl` (30.4 MB)
- `BFlute_060_20170630_Bird_Valid_HiRes.stl` (516 KB)
- Factory: `BFlute_060_BodyBird_S3D_ UM2p_100um_20170702.factory`
- Profile: `BFlute FCMG Ultimaker 2+ PLA as0f20170702_0553.fff`
- Based on:
- G-code: `BFlute_060_BodyBird_S3D_UM2p_100um_20170702.gcode` (31.5 MB)
- Slicer: Simplify3D 3.1.1
  - Profile differences from `Ultimaker 2+ S3D Pristine 20170630.fff`:
    - Auto-Configure for Material: ABS → PLA
    - Auto-Configure for Print Quality: Medium → High
    - General Settings / Infill Percentage: 30% (orig setting)
    - Primary Layer Height: 0.10mm (100µm) (orig setting)
    - Skirt layers: 2 → 1
    - Skirt Offset from Part: 4.00 → 0.00
    - Skirt Outlines: 2 → 10
    - Temperature / Primary Extruder T0: 1:205 → 1:220 (ColorFabb advises 210–230)
    - Temperature / Heated Build Platform T1: 1:60 (orig setting) (ColorFabb advises 50–60)
    - Default Printing Speed: 2500 mm/min (= 41.7 mm/sec) (ColorFabb advises 40–60 mm/sec). However, note that the default under-speed settings of 65% for outline and 70% for solid infill cause the actual print speed to be ***substantially*** slower than advised.
    - Avoid crossing outline for travel movements: OFF → ON
- Predicted build stats: Time: 9:13, Plastic weight: 56.54g (0.12 lb)
- Printer: UM2+/FCMG, 0.40mm brass E3D nozzle
- Filament: ColorFabb CorkFill 2.85mm; Processing Temp: 210–230°C.
- Live settings:
  - Nozzle temperature: 220°C
  - Build plate temperature: 60°C
  - Speed: 100%; Material Flow: 100%

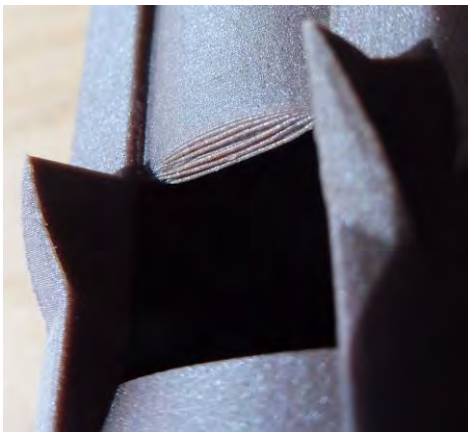
Print started 7/2/2017 at 6:00 AM. Unknown finish time – print picked up at 8AM on 7/3/2017.

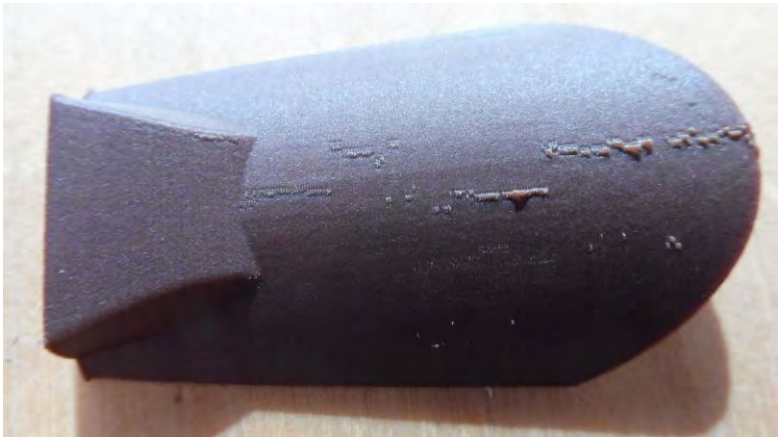
Weight of completed parts with 30% infill: Body: 1.590oz (45.08g); Bird: 0.136oz (3.84g)

Marking: Bird marked with "60A" in blue Sharpie.

Lacing added: 30″ (76 cm) long medium-wide leather lacing of unknown origin. This provides a nice length for three wraps with two 6″ tails.

Results: *Fantastic!* Print appears almost perfect. Issues: Bridging at the bottom of the flue is imperfect, some stringing internally, and there are “dots” or “bumps” on the exterior where the extruder switches between the body and the bird components:





Breath Flute #60 – 7/3/2017 Body & Bird in CorkFill on Ultimaker 2+

Print of body and bird components in one print using ColorFabb CorkFill (PLA/PHA 70%, Cork 30%) on the FCMG Ultimaker 2+ using 100µm Layers and **100% infill**.

- Printed: July 3, 2017
- Source: `BFlute_060.scad`
- STL: `BFlute_060_20170630_Body_Valid_HiRes.stl` (30.4 MB)
- `BFlute_060_20170630_Bird_Valid_HiRes.stl` (516 KB)
- Factory: `BFlute_060_BodyBird_S3D_UM2p_100um_100pct_20170703.factory`
- Profile: `BFlute FCMG Ultimaker 2+ PLA 100µm 100% as0f20170703_0737.fff`
- Based on: `Ultimaker 2+ S3D Pristine 20170630.fff`
- Based on:
- G-code: `BFlute_060_BodyBird_S3D_UM2p_100um_100pct_20170703.gcode` (31.5 MB)
- Slicer: Simplify3D 3.1.1
  - Profile differences from `Ultimaker 2+ S3D Pristine 20170630.fff`:
    - Auto-Configure for Material: ABS → PLA
    - Auto-Configure for Print Quality: Medium → High
    - General Settings / Infill Percentage: 30% → **100%**
    - Primary Layer Height: 0.10mm (100µm) (orig setting)
    - Skirt layers: 2 → 1
    - Skirt Offset from Part: 4.00 → 0.00
    - Skirt Outlines: 2 → 10
    - Infill / External Fill Pattern: Rectilinear → **Concentric**
    - Temperature / Primary Extruder T0: 1:205 → 1:220 (ColorFabb advises 210–230)
    - Temperature / Heated Build Platform T1: 1:60 (orig setting) (ColorFabb advises 50–60)
    - Default Printing Speed: 2500 mm/min (= 41.7 mm/sec) (ColorFabb advises 40–60 mm/sec). However, note that the default under-speed settings of 65% for outline and 70% for solid infill cause the actual print speed to be ***substantially*** slower than advised.
    - Avoid crossing outline for travel movements: OFF → ON
- Predicted build stats: Time: 12:26, Plastic weight: 86.50g (0.19 lb)
- Printer: UM2+/FCMG, 0.40mm brass E3D nozzle
- Filament: ColorFabb CorkFill 2.85mm; Processing Temp: 210–230°C.
- Live settings:
  - Nozzle temperature: 220°C
  - Build plate temperature: 60°C
  - Speed: 100%; Material Flow: 100%

Print started 7/3/2017 at 8:15 AM. Unknown finish time – print picked up at 11AM on 7/4/2017. Weight of completed parts with 100% infill: Body: 2.370oz (67.20g); Bird: 0.187oz (5.32g)

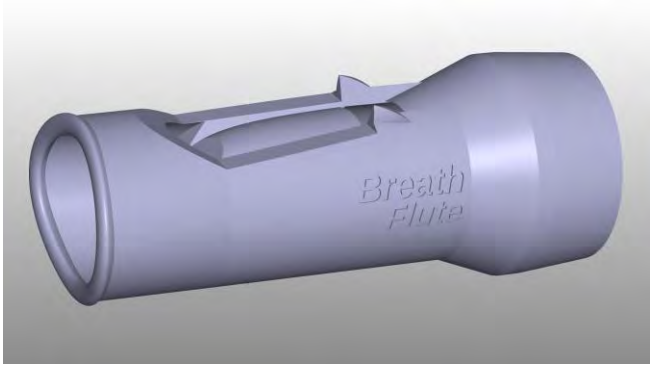
Results: Significant warping on the distal face of the Bird. Marking: Bird marked with "60B" in blue Sharpie.

Lacing added: 36″–37″ (93 cm) long ArtMinds Leather Lace Medium Brown (narrow) by Michaels Stores (part #168866). This provides a nice length for four wraps with two 7″ tails.

Breath Flute Design #61

Updates incorporated into Breath Flute prototype #61, July 4, 2017:

- Add lettering to the Bird to identify the part and avoid confusion (NOT DONE in this version).
- More distance – 4mm – near the foot end where the foot gets very thin – dangerous. This involved increasing BoreHeadLength from 30 to 34mm. This lengthens the overall headjoint from 12.6cm to 13.0cm (4.96″ to 5.12″).
- Relocate the side lettering – "Breath Flute" – down so it is no covered by the lacing.
- Need support for the sagging bridge area at the distal end of the flute in the body – the "Flue Bridge" area (this was implemented in #62).



Breath Flute #61 – Body & Bird in CorkFill on Ultimaker 2+, 100µm, 30% infill – 7/4/2017

Print of body and bird components in one print using ColorFabb CorkFill (PLA/PHA 70%, Cork 30%) on the FCMG Ultimaker 2+ using 100µm Layers and **30% infill**.

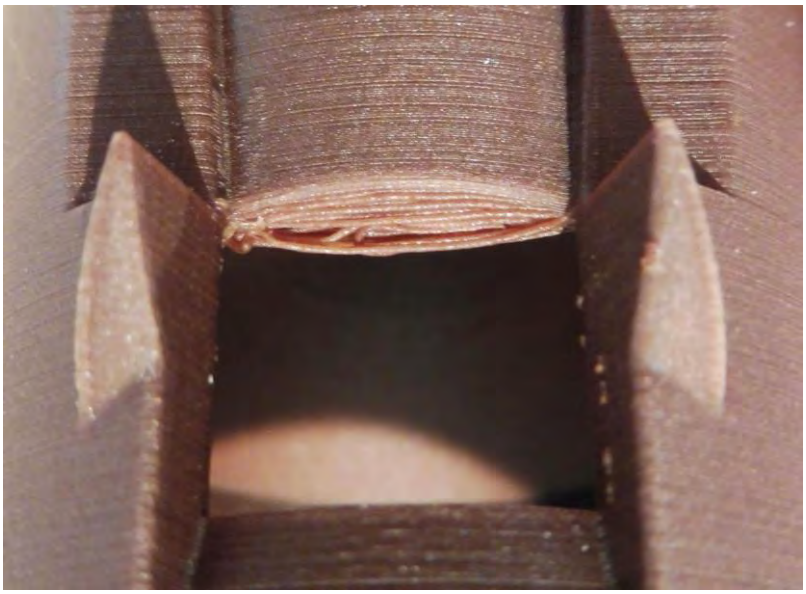
- Printed: July 4, 2017
- Source: `BFlute_061.scad`
- STL: `BFlute_061_20170704_Body_Valid_HiRes.stl` (30.3 MB)
- `BFlute_061_20170704_Bird_Valid_HiRes.stl` (516 KB)
- Factory: `BFlute_061_BodyBird_S3D_UM2p_Corkfill_100um_30pct_20170704.factory`
- Profile: `BFlute FCMG Ultimaker 2+ Corkfill 100µm 30% as0f20170704_1020.fff`
- Based on:
- G-code: `BFlute_061_BodyBird_S3D_UM2p_Corkfill_100um_30pct_20170704.gcode` (41.0 MB)
- Slicer: Simplify3D 3.1.1
  - Profile differences from `Ultimaker 2+ S3D Pristine 20170630.fff`:
    - Auto-Configure for Material: ABS → PLA
    - Auto-Configure for Print Quality: Medium → High
    - General Settings / Infill Percentage: 30% (orig setting)
    - Primary Layer Height: 0.10mm (100µm) (orig setting)
    - Skirt layers: 2 (orig setting)
    - Skirt Offset from Part: 4.00 → 0.00
    - Skirt Outlines: 2 → 10
    - Infill / External Fill Pattern: Rectilinear → **Concentric**

  - Temperature / Primary Extruder T0: 1:205 → 1:220 (ColorFabb advises 210–230)
  - Temperature / Heated Build Platform T1: 1:60 → **1:55** (ColorFabb advises 50–60)
  - Default Printing Speed: 2500 mm/min (= 41.7 mm/sec) (ColorFabb advises 40–60 mm/sec). However, note that the default under-speed settings of 65% for outline and 70% for solid infill cause the actual print speed to be ***substantially*** slower than advised.
  - Avoid crossing outline for travel movements: OFF → ON
- Predicted build stats: Time: 9:37, Plastic weight: 59.43g (0.13 lb)
- Printer: UM2+/FCMG, 0.40mm brass E3D nozzle
- Filament: ColorFabb CorkFill 2.85mm; Processing Temp: 210–230°C.
- Live settings:
  - Nozzle temperature: 220°C
  - Build plate temperature: **55°C**
  - Speed: 100%; Material Flow: 100%

Print started 7/4/2017 at 11:05 AM. Unknown finish time – print picked up at 6:35AM on 7/5/2017.

Weight of completed parts with 30% infill: Body: ?? oz (??.20g); Bird: 0.??oz (5.??g)

Results: additional material – the "FlueBlock" – added at the distal end of the flute to help with the bridging issues did ***not*** really help. Still have lots of stringing and sagging in that area.



Lacing added: 36″–37″ long ArtMinds Leather Lace Ivory (narrow) by Michaels Stores (part #168874). This provides a nice length for four wraps with two 7″ tails.

Finishing: This print was sanded, the hanging bridge at the distal end of the flue was trimmed, and it was completed on 6/26/2018!

Breath Flute #61 – 7/5/2017 Body & Bird in CorkFill on Ultimaker 2+

Print of body and bird components in one print using ColorFabb CorkFill (PLA/PHA 70%, Cork 30%) on the FCMG Ultimaker 2+ using 100µm layers and **100% infill**.

- Printed: July 5, 2017
- Source: `BFlute_061.scad`
- STL: `BFlute_061_20170704_Body_Valid_HiRes.stl` (30.3 MB)
- `BFlute_061_20170704_Bird_Valid_HiRes.stl` (516 KB)
- Factory: `BFlute_061_BodyBird_S3D_UM2p_Corkfill_100µm_100pct_20170705.factory`
- Profile: `BFlute FCMG Ultimaker 2+ Corkfill 100µm 100% as0f20170705_0610.fff`
- Based on:
- G-code: `BFlute_061_BodyBird_S3D_UM2p_Corkfill_100µm_100pct_20170705.gcode` (32.5 MB)

- Slicer: Simplify3D 3.1.1
  - Profile differences from `Ultimaker 2+ S3D Pristine 20170630.fff`:
    - Auto-Configure for Material: ABS → PLA
    - Auto-Configure for Print Quality: Medium → High
    - General Settings / Infill Percentage: 30% → **100%**
    - Primary Layer Height: 0.10mm (100µm) (orig setting)
    - Skirt layers: 2 (orig setting)
    - Skirt Offset from Part: 4.00 → 0.00
    - Skirt Outlines: 2 → 10
    - Infill / External Fill Pattern: Rectilinear → **Concentric**
    - Temperature / Primary Extruder T0: 1:205 → 1:220
    - Temperature / Heated Build Platform T1: 1:60 → **1:55**
    - Default Printing Speed: 2500 mm/min (= 41.7 mm/sec) (ColorFabb advises 40–60 mm/sec). However, note that the default under-speed settings of 65% for outline and 70% for solid infill cause the actual print speed to be ***substantially*** slower than advised.
    - Avoid crossing outline for travel movements: OFF → ON
- Predicted build stats: Time: 13:12, Plastic weight: 92.69g (0.2 lb)
  - Profile saved `to` (/CGModels & /S3D_Profiles)
- Printer: UM2+/FCMG, 0.40mm brass E3D nozzle
- Filament: ColorFabb CorkFill 2.85mm; Processing Temp: 210–230°C.
- Live settings:
  - Nozzle temperature: 220°C
  - Build plate temperature: **55°C**
  - Speed: 100%; Material Flow: 100%

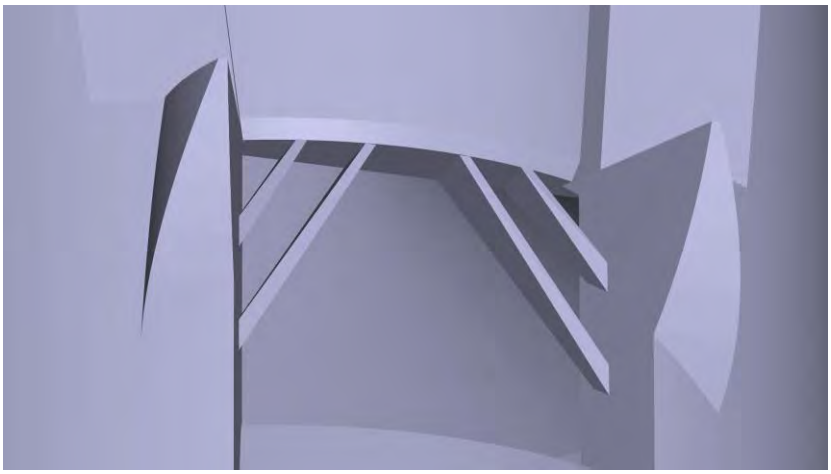
Print started 7/5/2017 at 6:45 AM. Unknown finish time – print picked up at 11AM on 7/6/2017.

Weight of completed parts with 100% infill: Body: ?? oz (??.20g); Bird: 0.??oz (5.??g)

Results: Significant bridging failure at the distal end of the flue.

Breath Flute Design #62

Added `TSHWedgeSupports()` to support the overhang at the distal end of the flue:



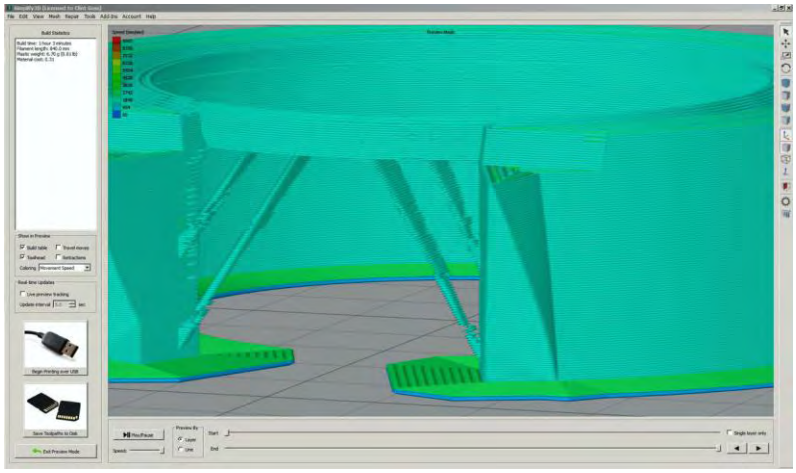
Breath Flute #62 – 7/6/2017 Slice of the TSH area in CorkFill on Ultimaker 2+

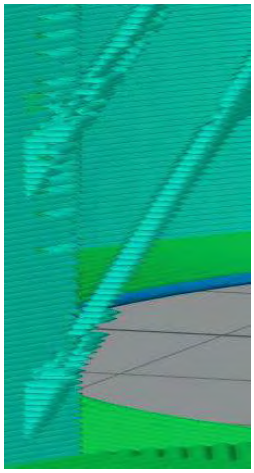
Test of the new TSH Wedge Supports using ColorFabb CorkFill (PLA/PHA 70%, Cork 30%) on the FCMG Ultimaker 2+ using 100µm layers and **100% infill**.

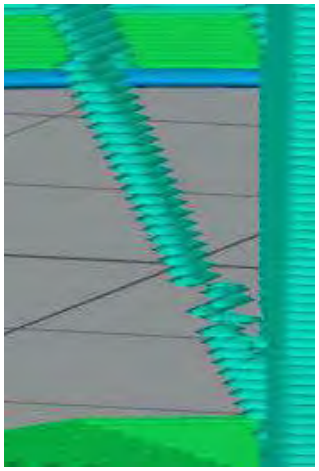
- Printed: July 6, 2017
- Source: `BFlute_062.scad`
- STL: `BFlute_062_20170706_Body_Valid_HiRes.stl` (30.4 MB)

- Factory: `BFlute_062_TSHSlice_S3D_UM2p_Corkfill_100um_100pct_20170707.factory`
- Profile: `BFlute FCMG Ultimaker 2+ Corkfill 100µm 100% TSHslice asOf20170707_0742.fff`
- Based on:
- G-code: `BFlute_062_20170706_SliceTSH_Valid_HiRes.gcode` (3.5 MB)
- Slicer: Simplify3D 3.1.1
  - Profile differences from `Ultimaker 2+ S3D Pristine 20170630.fff`:
    - Change Position: Z Offset: **-49.60 mm**
    - Auto-Configure for Material: ABS → PLA
    - Auto-Configure for Print Quality: Medium → High
    - General Settings / Infill Percentage: 30% → **100%**
    - Primary Layer Height: 0.10mm (100µm) (orig setting)
    - Skirt layers: 2 (orig setting)
    - Skirt Offset from Part: 4.00 → 0.00
    - Skirt Outlines: 2 → 10
    - Infill / External Fill Pattern: Rectilinear → **Concentric**
    - Temperature / Primary Extruder T0: 1:205 → 1:220
    - Temperature / Heated Build Platform T1: 1:60 → **1:55**
    - Default Printing Speed: 2500 mm/min (= 41.7 mm/sec) (ColorFabb advises 40–60 mm/sec). However, note that the default under-speed settings of 65% for outline and 70% for solid infill cause the actual print speed to be ***substantially*** slower than advised.
    - Avoid crossing outline for travel movements: OFF → ON
    - Advanced / Stop printing at height: **[ON] 11.00 mm**
- Predicted build stats: Time: 1:03, Plastic weight: 6.70g (0.01 lb)
- Printer: UM2+/FCMG, 0.40mm brass E3D nozzle
- Filament: ColorFabb CorkFill 2.85mm; Processing Temp: 210–230°C.
- Live settings:
  - Nozzle temperature: 220°C
  - Build plate temperature: **55°C**
  - Speed: 100%; Material Flow: 100%

The slicing preview shows some odd shapes on the supports:

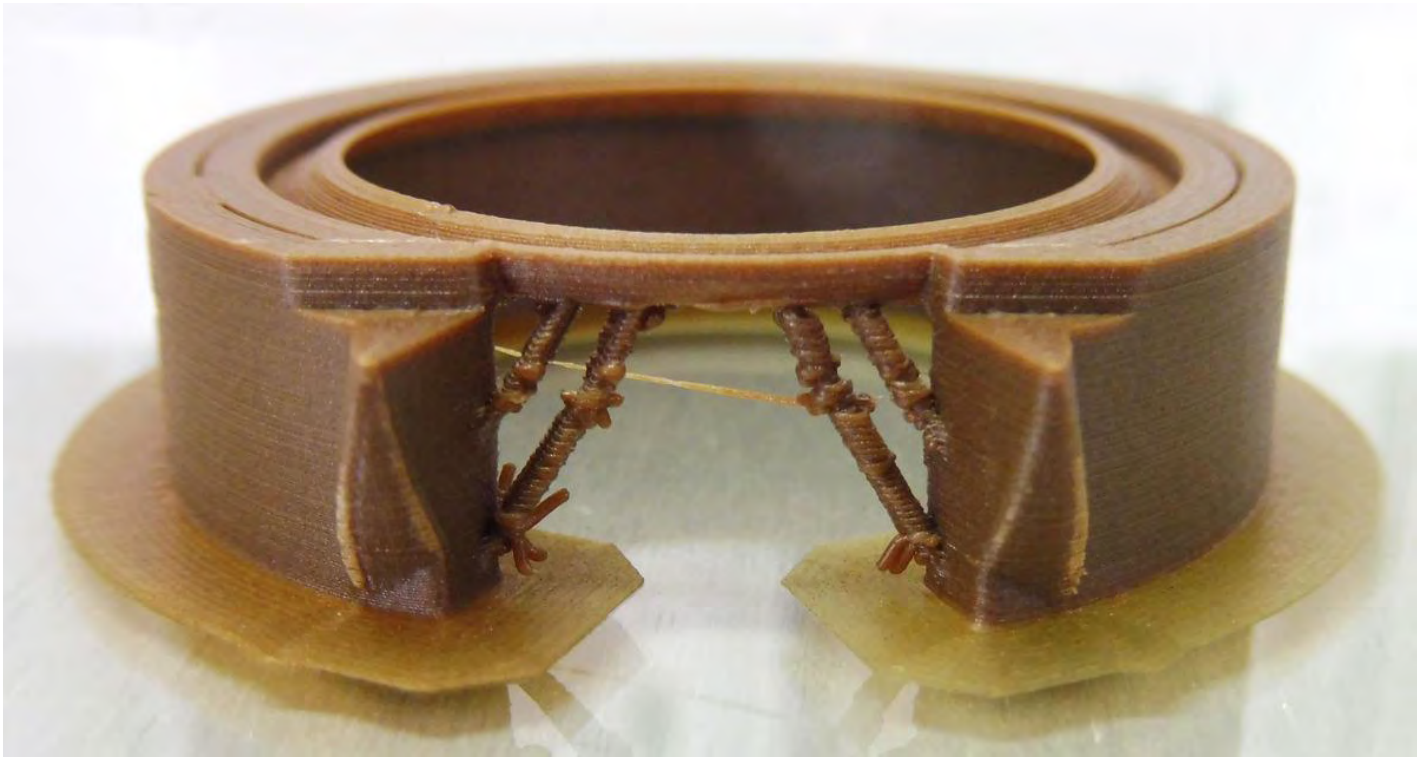






Print started 7/6/2017 at 11:33 AM. Unknown finish time – print picked up at 1PM on 7/6/2017.

Results: The odd shapes of the slicer preview seem to have borne out on the print, in odd and maybe different ways:



Breath Flute Design #63

- Remove TSH Wedge Supports – they didn't really work out so well, and the QWistle guy suggested I try getting bridging to work. DONE
- Modify the depth of the FlueBridge from 3.0mm to 2.1mm to reduce the unsupported overhang. DONE
- Change the shape of the bird cutoff / base. The problems are that the bottom of the flue stuck out above the sides, preventing the sides from being sanded nicely. Also, the two-surface base may cause problems – better to have a single surface so that the sides are flat and can be sanded directly.
  – Cannot figure out how to accomplish this! Alternate solution is to affix a gasket – 3M medium density, closed-cell tape cut out with a "cookie cutter" formed to the shape of the back and sides and stuck on to the headjoint body. The bird itself can easily be sanded flat.
- Angle the mouthpiece up so that the player can look up while the flute goes down at an angle – maybe 12°? DONE – LipRotationAngle was added.
- Change default layer height from 100µm to 80µm, based on suggestions in HowTo_Articles/ Ultimaker2_LayerHeight/ UM2_MagicLayerHeights.docx. DONE

Breath Flute Design #64

Version 63 did not slice well. The Flue Bridge – the additional block of material designed to augment and support the sagging, overhanging area at the distal end of the flue – wound up being sliced so that the toolpath printed the infill in empty space, before the edges. Version 64 removes the `FlueBridge()` and things print much nicer now – the distal end of the flue prints as two curved lines, supported by the ends. It would be better if they were straight lines, but one thing at a time …

Breath Flute #64 – Test Slices of the TSH area to optimize the Flue Bridge overhang

An attempt to cure the overhang sagging issues using custom settings in S3D when printing the Flue Bridge area.

Core profile is: `BFlute FCMG Ultimaker 2+ Corkfill 80um 100% as0f20170710_0640.fff`

- Slicer: Simplify3D 3.1.1
  - Profile differences from `Ultimaker 2+ S3D Pristine 20170630.fff`:
    - Auto-Configure for Material: ABS → **PLA**
    - Auto-Configure for Print Quality: Medium → **High**
    - General Settings / Infill Percentage: 30% → **100%**
    - Layer / Primary Layer Height: 0.10mm → **0.08mm (80µm)**
    - Layer / Outline/Perimeter Shells: 2 → **3**
    - Additions / Skirt layers: 2 (orig setting)
    - Additions / Skirt Offset from Part: 4.00 → **0.00**
    - Additions / Skirt Outlines: 2 → **10**
    - Infill / External Fill Pattern: Rectilinear → **Concentric**
    - Temperature / Primary Extruder T0: 1:205 → **1:220**
    - Temperature / Heated Build Platform T1: 1:60 → **1:55**
    - Other / Default Printing Speed: 2500 mm/min (= 41.7 mm/sec) (ColorFabb advises 40–60 mm/sec).
      However, note that the default under-speed settings of 65% for outline and 70% for solid infill cause the actual print speed to be ***substantially*** slower than advised.
    - Advanced / Avoid crossing outline for travel movements: OFF → **ON**

For all test prints:

- **Printed:** July 10, 2017
- **Source:** `BFlute_064.scad`
- **STL:** `BFlute_064_20170710_Body_Valid_HiRes.stl` (30.7 MB)
- **Factory:**
- **Profile:**
- **G-code:**
- Change Position: Z Offset: **-58.00 mm**
- Slicer: Simplify3D 3.1.1

For test prints A, B, and C:

- Printer: UM2+/FCMG, 0.40mm brass E3D nozzle
- Filament: ColorFabb CorkFill 2.85mm; Processing Temp: 210–230°C.
- Live settings: Nozzle temperature: (various)
  - Build plate temperature: **55°C**
  - Speed: 100%; Material Flow: 100%

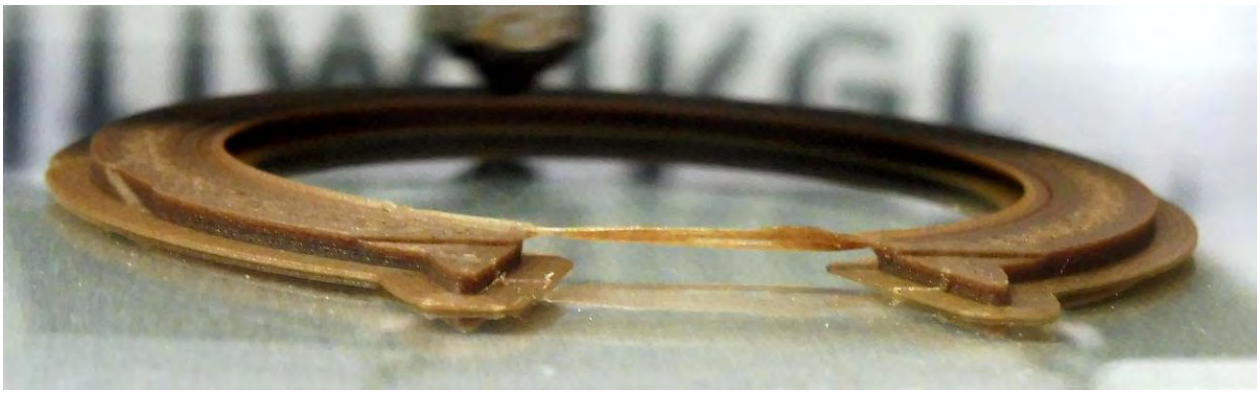
7/10/2017 Test Print UM2-A – Ultimaker 2+, 80µm Layers, 100% Infill, All 220°C

- **Printed:** July 10, 2017
- **Source:** `BFlute_064.scad`
- **STL:** `BFlute_064_20170710_Body_Valid_HiRes.stl` (30.7 MB)
- **Factory:** `BFlute_064_20170710_UM2_A.factory`
- **Profile:** `Test 20170710 UM2-A asOf20170710_0651.fff`
- **Based on:**
- **G-code:** `BFlute_064_20170710_UM2_A.gcode` (1.1 MB)
- Slicer: Simplify3D 3.1.1
  - Profile differences from `BFlute FCMG Ultimaker 2+ Corkfill 80um 100% asOf20170710_0640.fff`:
    - Additions / Skirt Outlines: 10 → **4**
    - Temperature / Primary Extruder T0: 1:220 (base profile setting)
    - Advanced / Stop printing at height: **[ON] 2.00 mm**
- Predicted build stats: Time: 0:17, Plastic weight: 1.29g (0.00 lb)

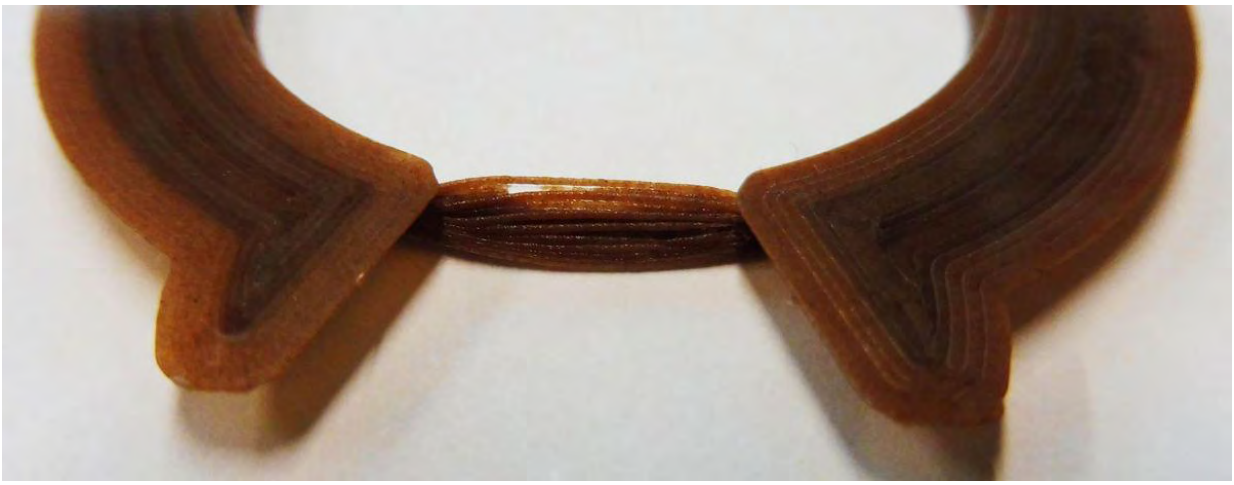
Results: Printer correctly read the temperature settings from the .gcode file. I had been setting the extruder and bed temperatures manually prior to this test!

Unacceptable level of stringing and collapse of the Flue Bridge area. The problem is really that the flue bridge is ***curved***. If it were straight, it might be able to hold up.

On the printer. First layer beginning to sag:



After printing, from below, showing many layers (5?) of collapsed bridging:



7/10/2017 Test Print UM2-B – Ultimaker 2+, 80µm Layers, 100% Infill, All 210°C

- **Printed:** July 10, 2017
- **Source:** `BFlute_064.scad`
- **STL:** `BFlute_064_20170710_Body_Valid_HiRes.stl` (30.7 MB)
- **Factory:** `BFlute_064_20170710_UM2_B.factory`
- **Profile:** `Test 20170710 UM2-B asOf20170710_0656.fff`
- **Based on:**
- **G-code:** `BFlute_064_20170710_UM2_B.gcode` (1.1 MB)
- Slicer: Simplify3D 3.1.1
  - Profile differences from `BFlute FCMG Ultimaker 2+ Corkfill 80um 100% asOf20170710_0640.fff`:
  - Additions / Skirt Outlines: 10 → **4**
  - Temperature / Primary Extruder T0: 1:220 → 1:**210**
  - Advanced / Stop printing at height: **[ON] 2.00 mm**
- Predicted build stats: Time: 0:17, Plastic weight: 1.29g (0.00 lb)

Results: Possibly better (less collapse of the Flue Bridge), but maybe not – minimal improvement, at best.

On the printer, showing stringing:

From below, after the print:

7/10/2017 Test Print UM2-C – Ultimaker 2+

Using 80µm layers, 100% Infill, 220→205°C.

- **Printed:** July 10, 2017
- **Source:** `BFlute_064.scad`
- **STL:** `BFlute_064_20170710_Body_Valid_HiRes.stl` (30.7 MB)
- **Factory:** `BFlute_064_20170710_UM2_C.factory`
- **Profile:** `Test 20170710 UM2-C1 as0f20170710_0800.fff` (Distal Process)
- `Test 20170710 UM2-C2 as0f20170710_0800.fff` (FlueBridge Process)
- **Based on:**
- **G-code:** `BFlute_064_20170710_UM2_C.gcode` (1.1 MB)
- Slicer: Simplify3D 3.1.1
  - *Distal* Process / Profile differences from `BFlute FCMG Ultimaker 2+ Corkfill 80um 100% as0f20170710_0640.fff`:
    - Additions / Skirt Outlines: 10 → **4**
    - Temperature / Primary Extruder T0: 1:220 (base profile setting)
    - Advanced / Stop printing at height: **[ON] 0.80 mm**
  - *FlueBridge* Process / Profile differences from `BFlute FCMG Ultimaker 2+ Corkfill 80um 100% as0f20170710_0640.fff`:
    - Additions / Skirt Outlines: 10 → **4**
    - Temperature / Primary Extruder T0: 1:220 → 1:**205**
    - Advanced / Start printing at height: **[ON] 0.80 mm**
    - Advanced / Stop printing at height: **[ON] 2.00 mm**
- Predicted build stats: Time: 0:17, Plastic weight: 1.29g (0.00 lb)

Results: Maybe slightly better, but still not usable. Still have collapse of the Flue Bridge.

On the printer, showing whispy stringing.

7/10/2017 Test Print UM2-T – Ultimaker 2+ with Timberfill Rosewood

Using 80µm layers, 100% Infill, at 180°C

https://shop3duniverse.com/products/creator-pro says: "Maximum resolution is 0.1 mm (100µm)."

- Printed: July 10, 2017
- Source: `BFlute_064.scad`
- STL: `BFlute_064_20170710_Body_Valid_HiRes.stl` (30.7 MB)
- Factory: `BFlute_064_20170710_UM2_T.factory`
- Profile: `BFlute FCMG Ultimaker 2+ Tfill Rwood 80um 100% as0f20170710_0820.fff`
- Based on:
- G-code: `BFlute_064_20170710_UM2_T.gcode` (1.1 MB)
- Slicer: Simplify3D 3.1.1
  - Profile differences from `Ultimaker 2+ S3D Pristine 20170630.fff`:
    - Change Position: Z Offset: **-58.00 mm**
    - Auto-Configure for Material: ABS → **PLA**
    - Auto-Configure for Print Quality: Medium → **High**
    - General Settings / Infill Percentage: 30% → **100%**
    - Layer / Primary Layer Height: 0.10mm → **0.08mm (80µm)**
    - Layer / Outline/Perimeter Shells: 2 → **3**
    - Additions / Skirt layers: 2 (orig setting)
    - Additions / Skirt Offset from Part: 4.00 → **0.00**
    - Additions / Skirt Outlines: 2 → **10**
    - Infill / External Fill Pattern: Rectilinear → **Concentric**
    - Temperature / Primary Extruder T0: 1:205 → **1:180**
    - Temperature / Heated Build Platform T1: 1:60 → **1:45**
    - Other / Default Printing Speed: 2500.0 mm/min → **1900.0 mm/min** (= 31.7 mm/sec) (Fillamentum advises 20–30 mm/sec).
      However, note that the default under-speed settings of 65% for outline and 70% for solid infill cause the actual print speed to be within the suggested range (65% = 20.6 mm/sec; 70% = 22.2 mm/sec).
    - Advanced / Avoid crossing outline for travel movements: OFF → **ON**
    - Advanced / Stop printing at height: **[ON] 2.00 mm**
- Predicted build stats: Time: 0:26, Plastic weight: 1.50g (0.00 lb)
- Printer: UM2+/FCMG, 0.40mm brass E3D nozzle
- Filament: Fillamentum Timberfill Rosewood 2.85mm; Processing Temp: 170–185°C.
- Live settings:
  - Nozzle temperature: **180°C** (Fillamentum advises 170 – 185 *or* 190°C).
  - Build plate temperature: **45°C** (Fillamentum advises 40–50°C).
  - Speed: 100%
  - Material Flow: 100%

Results: Printer clogged. This issue was a reported by a number of reviewers of this filament – seem, for example, Materials/ Fillamentum/ Fillamentum_Timberfill_Vase123.docx. Some suggest a larger nozzle helps (Vase-123 uses a 0.6mm nozzle). Also, the of this print above image shows the small hairs that some of the reviewers also supported. Also, the filament before printing is rather brittle and breaks easily when flexed. This material may be untenable.

7/10/2017 Test Print FFCP-A– FlashForge Creator Pro

Using Corkfill, 100µm layers, 100% Infill, all at 210°C.

https://shop3duniverse.com/products/creator-pro says: "Maximum resolution is 0.1 mm (100µm)."

- **Printed:** July 10, 2017
- **Source:** `BFlute_064.scad`
- **STL:** `BFlute_064_20170710_Body_Valid_HiRes.stl` (30.7 MB)
- **Factory:** `BFlute_064_20170710_FFCP_A.factory`
- **Profile:** `BFlute FCMG FFCP Corkfill 100µm 100% asOf20170710_0840.fff`
- **Based on:**
- **G-code:** `BFlute_064_20170710_FFCP_A.gcode` (0.9 MB)
- `BFlute_064_20170710_FFCP_A.x3g` (1.0 MB)
- Slicer: Simplify3D 3.1.1
  - Profile differences from `FlashForge Creator Pro S3D Pristine 20170630.fff`:
    - Change Position: Z Offset: **-58.00 mm**
    - Auto-Configure for Material: ABS → **PLA**
    - Auto-Configure for Print Quality: Medium → **High**
    - Auto-Configure Extruders: Right Extruder Only (orig setting)
    - General Settings / Infill Percentage: 30% → **100%**
    - Layer / Primary Layer Height: 0.10mm (orig setting)
    - Layer / Outline/Perimeter Shells: 2 → **3**
    - Additions / Skirt layers: 2 (orig setting)
    - Additions / Skirt Offset from Part: 4.00 → **0.00**
    - Additions / Skirt Outlines: 2 → **10**
    - Infill / External Fill Pattern: Rectilinear → **Concentric**
    - Temperature / Primary Extruder T0: 1:230 → **1:210**
    - Temperature / Heated Build Platform T1: 1:60 → **1:55**
    - Other / Default Printing Speed: 3600.0 mm/min (= 60 mm/sec) (ColorFabb advises 40–60 mm/sec). However, note that the default under-speed settings of 65% for outline and 70% for solid infill cause the actual print speed to be within range).
    - Advanced / Avoid crossing outline for travel movements: OFF → **ON**
    - Advanced / Stop printing at height: **[ON] 2.00 mm**
- Predicted build stats: Time: 0:12, Plastic weight: 1.30g (0.00 lb)
- Printer: FFCP/FCMG, 0.40mm brass E3D nozzle
- Filament: ColorFabb CorkFill **1.75mm**; Processing Temp: 210–230°C.
- Live settings:
  - Nozzle temperature: **210°C** (ColorFabb advises 210 – 230°C).
  - Build plate temperature: **55°C** (ColorFabb advises 50–60°C).
  - Speed: 100%
  - Material Flow: 100%

Results:

Print never got started, because the right extruder of the FFCP printer was loaded with and ABS filament that I could not unload. Have to switch to the LEFT extruder.

7/10/2017 Test Print FFCP-B – FlashForge Creator Pro,

Using Corkfill, 100µm layers, 100% Infill, all at 210°C. Same as FFCP-A, except switched to the left extruder. Slicing done at the FFMG club. Differences are:

- Printed: July 10, 2017
- Source: `BFlute_064.scad`
- STL: `BFlute_064_20170710_Body_Valid_HiRes.stl` (30.7 MB)
- Factory: `BFlute_064_20170710_FFCP_B.factory`
- Profile: `BFlute_064_20170710_FFCP_B.fff`
- Based on:
- G-code: `BFlute_064_20170710_FFCP_B.gcode` (0.9 MB)
- `BFlute_064_20170710_FFCP_B.x3g` (1.0 MB)
- Slicer: Simplify3D 3.1.1
  - Profile differences from the `FFCP-A` profile:
    - Auto-Configure Extruders: Right Extruder Only (orig setting) forgot to change this!
    - Temperature / Primary Extruder T1: 1:0 → **1:210**

Results: Failed … Left extruder never came up to temperature.

7/10/2017 Test Print on FFCP-C – FlashForge Creator Pro

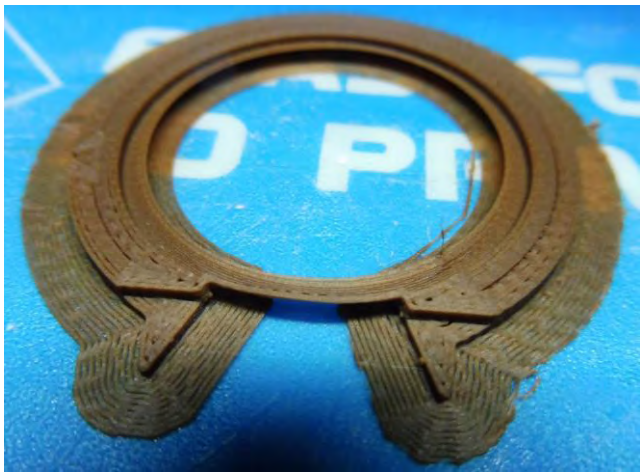
Using Corkfill, 100µm layers, 100% Infill, all at 210°C. Same as FFCP-B, except corrected the Auto-Configure Extruders setting. Slicing done at the FFMG club. Differences are:

- Printed: July 10, 2017
- Source: `BFlute_064.scad`
- STL: `BFlute_064_20170710_Body_Valid_HiRes.stl` (30.7 MB)
- Factory: `BFlute_064_20170710_FFCP_C.factory`
- Profile: `BFlute_064_20170710_FFCP_C.fff`
- Based on:
- G-code: `BFlute_064_20170710_FFCP_C.gcode` (0.9 MB)
- `BFlute_064_20170710_FFCP_C.x3g` (1.0 MB)
- Slicer: Simplify3D 3.1.1
  - Profile differences from the `FFCP-A` profile:
    - Auto-Configure Extruders: **Left Extruder Only**
    - Temperature / Primary Extruder T1: 1:0 → **1:210**

Results: Successfully printed (first time!) on the FFCP! Bed and extruder correctly heat up. However …

Nowhere as finely printed as the UltiMaker 2+. Flue Bridge collapses in much the same way as the UM2+ (although this is not shown in these photos).

On the printer, and after removal from the printer, on a table:



Breath Flute Design #65

Design work done July 13-16, 2017. No prints were made at this time.

The v64 tests showed that the Flue Bridge is unlikely to print cleanly at any temperature, probably due to its inherent curved shape. Some choices and ideas:

- Cut the `Headjoint` in two, a la the QWistle headjoint section. DONE – this is the selected change for v65. This is called the SplitBody design with the `BodyProx` and `BodyDist` halves

… Other ideas were *not* implemented:

- Re-design to provide a straight-line base to the Flue Bridge (extend the old flue bridge *down* a bit?)
- Provide a straight-line support under the Flue Bridge – a single-width layer that comes up under the Flue Bridge, constructed from a thin cylinder. It would have to be tilted, so that it intersects the existing sides. It would need a V-shaped notch cut out of the center. It would also need post-processing removal – maybe easily done with a combination of a dremel and file to take it up to the flue bridge, whose location could be indicated by a small non-supported segment in the center of the flue bridge.
- Simply file down the dangling parts and hopefully we have enough left.

Other things implemented in the v65 design:

- Measured the shrinkage factor with the new [Calib] table in the `3D_Printing.xlsx` database. Shows a 0.8% – 0.9% shrinkage factor in the X-Y plane on the UltiMaker 2+ using Corkfill for Prototype #61 (220°C). DONE
- The body tube does not fit in the distal end of the headjoint. Add a scaling factor for `Shrink_XY_Pct` and `Expand_XY_Factor` so that the mortice can be expanded by that amount. DONE
- Increase `FlueWall_Thickness` and `Ramp_Thickness` from 0.50 to 1.00 to get more "beefiness" in these components. DONE

Note that the distal end of the closed cavity inside the `BodyProx` component (above the top end of the sound chamber) is not *filled in* solid to provide added heft to the two-part design.

Breath Flute #66 – Continued development of the Split Body (two-part headjoint) design

A new version / prototype number on resumption of design work on November 15, 2017.

Upgrade Simplify3D (S3D) from v3.1.1 to 4.0.0. On launch (not at first, but after a few launches) frequently get "Import Failed – Failed to parse XML file – Encountered incorrectly encoded content" in a dialog box on launch of S3D.

> This is caused by a "µ" character in the name of the profile. DO NOT USE non-ASCII CHARACTERS IN PROFILE NAMES!

Issues:

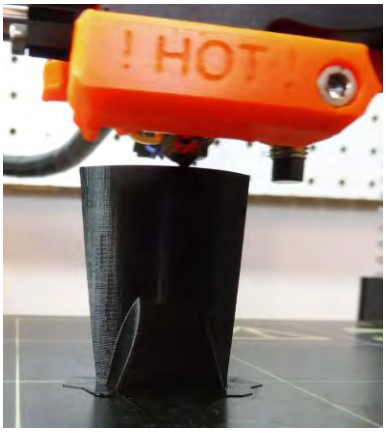
- There is a gap between the lip and the cylindrical portion at the head end of the headjoint – on the left and right sides. Needs to be adjusted. *Fixed – with introduction of the SAC3topFudgeFactor and the dual angled (inflected) top to the SAC.*
- Need a factor to bias the two SplitBody shapes (actually, just the bevel cylinder) so that there is no chance of "incomplete seating" of the `BodyProx` in the `BodyDist`. i.e. When you insert the `BodyProx`, it should go all the way in the sleeve of the `BodyDist` and reach the stopping point. *Fixed – with introduction of the SplitBodyComponentBiasZaxis*

11/16/2017 Print of 3 Components in CorkFill on FCMG Ultimaker 2+

Print of body and bird components in one print using ColorFabb CorkFill (PLA/PHA 70%, Cork 30%) on the FCMG Ultimaker 2+ using **80µm Layers** and **100% infill** at **3800 mm/min**.

- Printed: November 16, 2017
- Source: `BFlute_066.scad`
- STL: `BFlute_066_20171115b_Bird_Valid_HiRes.stl` (516 KB)
- `BFlute_066_20171115b_BodyDist_Valid_HiRes.stl` (3.5 MB)
- `BFlute_066_20171116b_BodyProx_INValid_HiRes.stl` (27.6 MB)
- Factory: `BFlute_066_20171116b_3Parts_S3D_UM2p_Corkfill_80um_100pct_3800.factory`
- Profile: `BFlute FCMG Ultimaker 2+ Corkfill 80um 100% 3800 asOf20171116.fff`
- Based on:
- G-code: `BFlute_066_20171116b_3Parts_S3D_UM2p_Corkfill_80um_100pct_3800.gcode` (98.3 MB)
- Slicer: Simplify3D 4.0.0.
  - Profile differences from `Ultimaker 2+ S3D Pristine 20170630.fff`:
    - Auto-Configure for Material: ABS → **PLA**
    - Auto-Configure for Print Quality: Medium → **High**
    - General Settings / Infill Percentage: 30% → **100%**
    - Layer / Primary Layer Height: 0.10mm (100µm) → **0.08mm (80µm)**
    - Layer / Outline/Perimeter Shells: 2 → **3**

        - Additions / Skirt layers: 2 (orig setting)
        - Additions / Skirt Offset from Part: 4.00 → **0.00**
        - Additions / Skirt Outlines: 2 → **10**
        - Infill / External Fill Pattern: Rectilinear → **Concentric**
        - Temperature / Primary Extruder T0: 1:205 → **1:220** (ColorFabb advises 210–230)
        - Temperature / Heated Build Platform T1: 1:60 → **1:55** (ColorFabb advises 50–60)
        - Speeds / Default Printing Speed:
          2500 mm/min (= 41.7 mm/sec)
          → **3800 mm/min** (= 63.3 mm/sec) (ColorFabb advises 40–60 mm/sec)
          With the default under-speed settings of 65% for outline and 70% for solid infill, the actual print speed works out to: 41.2 mm/sec for outline and 44.3 mm/sec for solid infill.
        - Advanced / Avoid crossing outline for travel movements: OFF → **ON**
    - Build Processes
        - `Bird`, `BodyDist`, and `BodyProx` processes, all with the Profile above
        - In each process, use [Select Models] (lower left) to select corresponding models.
    - Prepare to Print
        - Process Selection: Select all three processes
        - Printing Mode: Sequential printing; Max height clearance 3.00 mm
- Predicted build stats: Time: 14h 8m, Plastic weight: 97.57g (0.22 lb)
- Printer: UM2+/FCMG, 0.40mm brass E3D nozzle
- Filament: ColorFabb CorkFill 2.85mm; Processing Temp: 210–230°C.
- Live settings:
    - Nozzle temperature: 220°C
    - Build plate temperature: **55°C**
    - Speed: 100%; Material Flow: 100%



Unable to print because the UM2+/FCMG was jammed. Also, the FFCP printer was down for repairs (burned out mother board, due to printing ABS with a very high build plate temperature (130°C!). However, the Prusa i3 Mk2 was available. I did not have the 1.75mm Corkfill on hand, so I printed just the bird component, using the installed 1.75 mm black PLA on the printer, using a slicer setup developed on-site.

Print started 11/16/2017 at 10:00 AM. Finish time 12:12PM (2h 12m print time).

Weight of completed parts with 100% infill: Bird: 0.??oz (5.??g)

Results: Bird (black PLA) came out great!

Also developed strategies for sequential printing on the Pi3Mk2 and UM2+ printers while on-site. Development on the Shiba laptop saved and rolled forward to the next version ...

Breath Flute #67 – Re-target to the Prusa i3 Mk2 printer with Sequential Printing – 11/17/2017

Issues addressed:

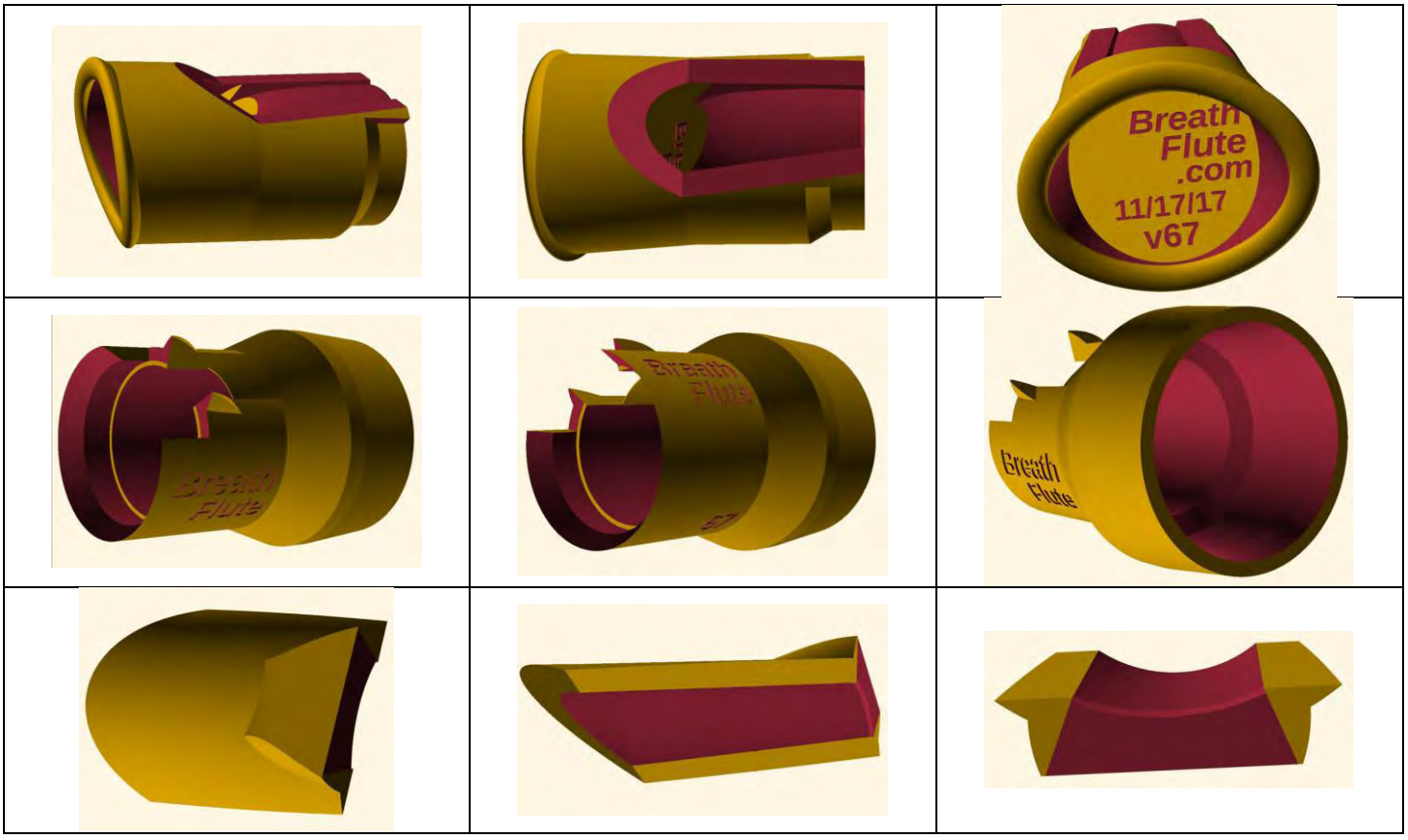
- The rendering of the STL in OpenSCAD comes out invalid, with 3 objects (4 are listed in the 3D-Tool viewer). This needs to be addressed.
- Adjust printing on the Ramp (inside the SAC) for better ledgibility. Done.
- Add printing of the version number on the outside. Done.
- Change layer height from standard …

Layer Height

Calc of suggested Layer Height for Prusa – from
https://www.reddit.com/r/3Dprinting/comments/6jliof/basic_question_minimum_layer_height_for_prusa_i3/?st=ja3qiwjb&sh=0d64778c

> I'm assuming these are 8mm travel per turn on the z threaded rod steppers, and 1.8 degree steppers and 1/16th microstepping. sooo... 200 full steps per revolution, 3200 microsteps per revolution. 400 microsteps per mm. .0025mm per 1/16 microstep. Full steps are more accurate, so .0025mm * 16 = .04mm

So … will use 80µm …



11/17/2017 Print of 3 Components in CorkFill on FCMG Prusa i3 Mk2

Printed with 80µm layers, 100% infill @ 3300 mm/min. Fetched the latest Prusa profile using the Configuration Agent in Simplify3D ("Prusa Research Original Prusa i3 MK2") and saved it as: `Prusa i3 Mk2 S3D Pristine 20171117.fff`

Print of body and bird components in one print using ColorFabb CorkFill (PLA/PHA 70%, Cork 30%) on the FCMG Prusa i3 Mk2 using **80µm Layers** and **100% infill** at **3300 mm/min.**

- Printed: November 17, 2017
- Source: `BFlute_067.scad`
- STL: `BFlute_067_20171117_Bird_Valid_HiRes.stl` (516 KB)
- `BFlute_067_20171117_BodyDist_Valid_HiRes.stl` (3.5 MB)
- `BFlute_067_20171117_BodyProx_INValid_HiRes.stl` (27.6 MB)
- Factory: `BFlute_067_20171117_3Parts_S3D_Pi3Mk2_Corkfill_80um_100pct_3300.factory`
- Profile: `BFlute FCMG Pi3Mk2 Corkfill 80um 100% 3300 20171117.fff`
- Based on:
- G-code: `BFlute_067_20171117_3Parts_S3D_Pi3Mk2_Corkfill_80um_100pct_3300.gcode` (65.5 MB)
- Slicer: Simplify3D 4.0.0
  - Profile differences from `Prusa i3 Mk2 S3D Pristine 20171117.fff`:
    - Auto-Configure for Print Quality: Medium → **High**
    - General Settings / Infill Percentage: 30% → **100%**
    - Layer / Primary Layer Height: 0.10 mm (100µm) → **0.08 mm (80µm)**
    - Layer / Outline/Perimeter Shells: 2 → **3**
    - Additions / Skirt layers: 2 (orig setting)
    - Additions / Skirt Offset from Part: 4.00 mm → **0.00 mm**
    - Additions / Skirt Outlines: 2 → **10**
    - Infill / External Fill Pattern: Rectilinear → **Concentric**
    - Temperature / Primary Extruder T0: 1:200 → **1:220** (ColorFabb advises 210–230)
    - Temperature / Heated Build Platform T1: 1:60 → **1:55** (ColorFabb advises 50–60)
    - Speeds / Default Printing Speed:
      2400 mm/min (= 40 mm/sec)
      → **3300 mm/min** (= 55 mm/sec) (ColorFabb advises 40–60 mm/sec)
      With all default under-speed settings of 80%, the actual print speed works out to 32 mm/sec. Setting the speed to 3300 with the 80% under-speed gives a net speed of 44 mm/sec.
    - Advanced / Movement Behavior / Avoid crossing outline for travel movements: OFF → **ON**
  - Build Processes
    - `Bird`, `BodyDist`, and `BodyProx` processes, all with the Profile above
    - In each process, use [Select Models] (lower left) to select corresponding models.
  - Positioning 3 components on the build plate for Sequential Printing on the Prusa i3 Mk2:
    - Print head is 50mm square with nozzle near the center and sensor at the back right.
    - Horizontal control rod is >= 30mm above the print head
    - `Bird`: [125, 95]

    - `BodyDist`: [210, 135]
    - `BodyProx`: [45, 135]
  - Click [Prepare to Print]
    - Process Selection: Select all three processes
    - Printing Mode: Sequential printing; Max height clearance 25.00 mm
- Predicted build stats: Time: 14h 30m, Filament length: 34.390 m, Plastic weight: 103.40g (0.23 lb)
- Printer: Pi2Mk2/FCMG, 0.40mm brass E3D nozzle
- Filament: ColorFabb CorkFill 1.75mm; Processing Temp: 210–230°C.
- Live settings:
  - Nozzle temperature: 220°C
  - Build plate temperature: **55°C**
  - Speed: 100%; Material Flow: 100%

Print started 11/17/2017 at 11:56 AM. Print time reported by the Prusa as 16 hours, 54 minutes, so Finish time was 4:50AM.

Disaster! The attempted sequential print failed for unknown reasons. Most of the Bird and 2/3 of the `BodyProx` components printed. The `BodyDist` component did have a balled up clog of filament, with lots of extruded filament thread all over the place (including wrapped *around* a belt underneath the hotbed).

The Bird component was in its proper location, and still stuck to the print bed. However, the `BodyProx` component may have been dragged all over the place … see the score marks on the print bed.

The partial print of the `BodyProx` component does demonstrate a potential issue. Look at the sliced-off ramp edge, just below the ".com" in the photo. It appears to have two distinct layers. These layers are barely (if at all) connected to each other. If you insert a fingernail between the two layers, you can get one to move a bit without the other.

Is this an issue? Not sure, but I'm thinking it would be better if they were one piece. That would probably be accomplished by making the ramp thicker.

Breath Flute #68 – Improvements 11/18/2017

Done.

Issues addressed:

- Came up with the idea of adding three aligned cylindrical "peg holes" in the `BodyProx` and `BodyDist` components that will accept a small dowel rod or screw to keep them fastened together! Done.
- Quickly improved to five set-screw peg holes based on Fastenal SKU 25116 #6-32 × ¼" Hex Drive Flat Point Black Oxide Finish Alloy Steel Socket Set Screw. Specs for threads from Wikipedia.

Also purchased Inlay Veneers from the Woodworker's Club – Sauers & Co. item 187-006-2, 3/16" × 1/28" × 36" (two), White Maple and Mahogany. However, have to wait till the next version to add these into the model.

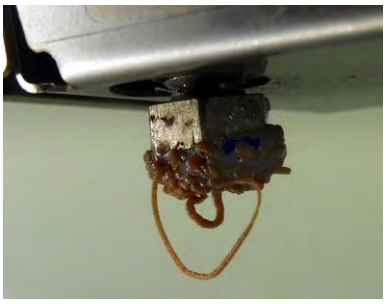
Also need to address the issue of the ramp thickness, as shown at the end of the description of #67 above.

11/18/2017 Print of 3 Components in CorkFill on Ultimaker 2

Print of body and bird components in one print using ColorFabb CorkFill (PLA/PHA 70%, Cork 30%) on the FCMG Ultimaker 2+ using **80µm Layers** and **100% infill** at **3800 mm/min**.

- Printed: November 18, 2017
- Source: `BFlute_068.scad`
- STL: `BFlute_068_20171118_Bird_Valid_HiRes.stl` (516 KB)
- `BFlute_068_20171118_BodyDist_Valid_HiRes.stl` (5.7 MB)
- `BFlute_068_20171118_BodyProx_INValid_HiRes.stl` (29.4 MB)
- Factory: `BFlute_068_20171118_3Parts_S3D_UM2p_Corkfill_80um_100pct_3800.factory`
- Profile: `BFlute FCMG Ultimaker 2+ Corkfill 80um 100% 3800 asOf20171115_1808.fff`
- Based on:
- G-code: `BFlute_068_20171118_3Parts_S3D_UM2p_Corkfill_80um_100pct_3800.gcode` (98.3 MB)
- Slicer: Simplify3D 4.0.0
  - Profile differences from `Ultimaker 2+ S3D Pristine 20170630.fff`:
    - Auto-Configure for Material: ABS → **PLA**
    - Auto-Configure for Print Quality: Medium → **High**
    - General Settings / Infill Percentage: 30% → **100%**
    - Layer / Primary Layer Height: 0.10mm (100µm) → **0.08mm (80µm)**
    - Layer / Outline/Perimeter Shells: 2 → **3**
    - Additions / Skirt layers: 2 (orig setting)

        - Additions / Skirt Offset from Part: 4.00 → **0.00**
        - Additions / Skirt Outlines: 2 → **10**
        - Infill / External Fill Pattern: Rectilinear → **Concentric**
        - Temperature / Primary Extruder T0: 1:205 → **1:220** (ColorFabb advises 210–230)
        - Temperature / Heated Build Platform T1: 1:60 → **1:55** (ColorFabb advises 50–60)
        - Speeds / Default Printing Speed:
          2500 mm/min (= 41.7 mm/sec)
          → **3800 mm/min** (= 63.3 mm/sec) (ColorFabb advises 40–60 mm/sec)
          With the default under-speed settings of 65% for outline and 70% for solid infill, the actual print speed works out to: 41.2 mm/sec for outline and 44.3 mm/sec for solid infill.
        - Advanced / Avoid crossing outline for travel movements: OFF → **ON**
    - Build Processes
        - `Bird`, `BodyDist`, and `BodyProx` processes, all with the Profile above
        - In each process, use [Select Models] (lower left) to select corresponding models.
    - Positioning 3 components on the build plate for Sequential Printing on the Ultimaker 2+:
        - Print head is 6 mm below the surrounding elements. We position elements fairly close to one another and just honor the 6mm clearance for sequential printing.
        - `Bird`: [110, 120]
        - `BodyDist`: [140, 135]
        - `BodyProx`: [85, 135]
    - Click [Prepare to Print]
        - Process Selection: Select all three processes
        - Printing Mode: Sequential printing; Max height clearance 4.00 mm
- Predicted build stats: Time: 14h 48mm, Filament length: 13.182 m, Plastic weight: 105.12g (0.23 lb)
- Printer: UM2+/FCMG, 0.40mm brass E3D nozzle
- Filament: ColorFabb CorkFill 2.85mm; Processing Temp: 210–230°C.
- Live settings:
    - Nozzle temperature: 220°C
    - Build plate temperature: **55°C**
    - Speed: 100%; Material Flow: 100%



Print attempted on 11/18/2017 at 3PM. Repeated attempts to get the print started failed miserably. On each of 5 – 6 tries, the material would not stick to the bed. The nozzle dragged the material along and it subsequently became wrapped around the nozzle. Consulted with Vladimir by email. Possible causes:

- Bed too close to the print nozzle (too high). It appears as though the material cannot extrude from the nozzle. This might be related to earlier observations about the thin first layer in one corner of the print.
- Bed temp too low.

- Print speed on first layer too high.
- Ambient room temperature too low. Might be affecting the print.

11/18/2017 Print of 3 Components in CorkFill on FCMG Prusa i3 Mk2

Attempted print of 3 components using the prior profile with 80µm, 100% infill @ 3300 mm/min. Setup and G-code rendered at FCMG:

- Printed: November 18, 2017
- Source: `BFlute_068.scad`
- STL: `BFlute_068_20171118_Bird_Valid_HiRes.stl` (516 KB)
- `BFlute_068_20171118_BodyDist_Valid_HiRes.stl` (5.7 MB)
- `BFlute_068_20171118_BodyProx_INValid_HiRes.stl` (29.4 MB)
- Factory: `BFlute_068_20171118_3Parts_S3D_Pi3Mk2_Corkfill_80um_100pct_3300.factory`
- Profile: `BFlute FCMG Pi3Mk2 Corkfill 80um 100% 3300 20171117.fff`
- Based on:
- G-code: `BFlute_067_20171118_3Parts_S3D_Pi3Mk2_Corkfill_80um_100pct_3300.gcode` (65.5 MB)
- Slicer: Simplify3D 4.0.0
  - Click [Prepare to Print]
    - Process Selection: Select all three processes
    - Printing Mode: Sequential printing; Max height clearance **5.00 mm**
- Predicted build stats: Time: 14h 31m, Filament length: 34.276 m, Plastic weight: 103.06g (0.23 lb)

Failed horribly! … In much the same way as the Ultimaker failure. Finally got the initial component – the bird – to "stick" to the bed, but when it moved to the second component, the initial skirt layer failed, and it began wrapping the head with filament.

> From this it appears that a sequential print using parts that are widely separated cannot be printed reliably, because getting the brim of the second and third parts to stick is a bit of a crap shoot.

Sigh.

11/18/2017 Print of BodyDist in CorkFill on FCMG Prusa i3 Mk2

Print of just the `BodyDist` component using the prior profile with 80µm layers, 100% infill @ 3300 mm/min. Setup and G-code rendered at FCMG:

- Printed: November 18, 2017
- Source: `BFlute_068.scad`
- STL: `BFlute_068_20171118_BodyDist_Valid_HiRes.stl` (5.7 MB)
- Factory: `BFlute_068_20171118_BodyDist_S3D_Pi3Mk2_Corkfill_80um_100pct_3300.factory`
- Profile: `BFlute FCMG Pi3Mk2 Corkfill 80um 100% 3300 20171117.fff`
- Based on:

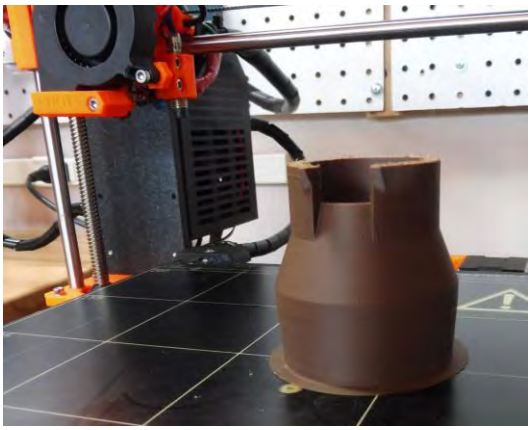
- G-code: `BFlute_067_20171118_BodyDist_S3D_Pi3Mk2_Corkfill_80um_100pct_3300.gcode` (30.7 MB)
- Slicer: Simplify3D 4.0.0
  - Click [Prepare to Print]
    - Process Selection: Select just the `BodyDist` component / process
    - Printing Mode: Continuous printing: layer-by-layer
- Predicted build stats: Time: 6h 7m, Filament length: 6.420 m, Plastic weight: 49.37g (0.23 lb)

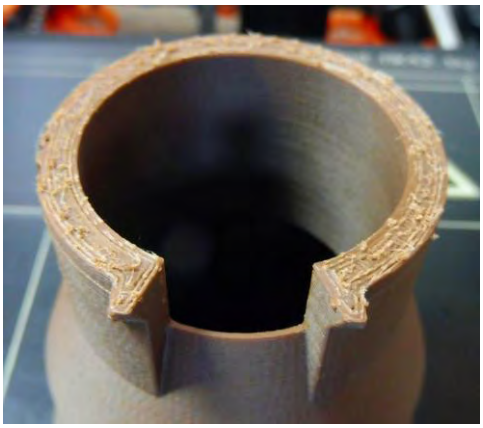
Print started 11/18/2017 at about 4:30PM … I "stuck around" until the brim printed and a few more layers.

Note that the first lay does have "problem" printing in a few places, but these seem to somehow become "masked over" by higher layers … maybe they kind of "melt"?

Results: Could not return to the club due to the lock-out (see below) until 11/20/2017 at noon. Printer still sitting quietly with the statistics: Print time reported by the Prusa as 7 hours, 25 minutes.

Print failed most of the way up the print:





It appears to have clogged the nozzle, an assessment confirmed by the fact that I could not push material at all (except a bit of material at 230°C. However –

> This part fits a PVC pipe perfectly!

11/19/2017 Print of BodyProx in CorkFill on FCMG Pi3Mk211/19/2017

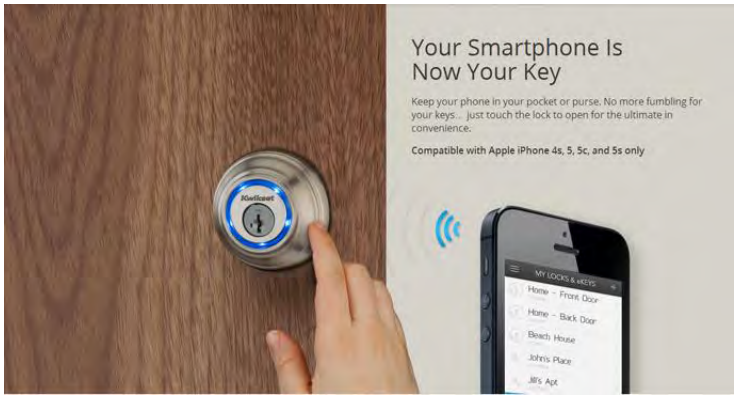
Printing at 80µm layers, 100% infill, at 3000 mm/min. New profile based on `Prusa i3 Mk2 S3D Pristine 20171117.fff`

Print of `BodyProx`: ColorFabb CorkFill, FCMG Prusa i3 Mk2, **80µm layers, 100% infill,** at 3000 **mm/min**.

- Printed: November 19, 2017
- Source: `BFlute_068.scad`
- STL: `BFlute_068_20171118_Bird_Valid_HiRes.stl` (516 KB)

- `BFlute_068_20171118_BodyDist_Valid_HiRes.stl` (5.7 MB)
- `BFlute_068_20171118_BodyProx_INValid_HiRes.stl` (29.4 MB)
- Factory: `BFlute_068_20171119_BdProx_S3D_Pi3m2_Ckfill_80um_100pct_3000.factory`
- Profile: `BFlute Pi3m2 Corkfill 80um 100% 3000 20171119.fff`
- Based on:
- G-code: `BFlute_068_20171119_BdProx_S3D_Pi3m2_Ckfill_80um_100pct_3000.gcode` (28.0 MB)
- Slicer: Simplify3D 4.0.0
  - Profile differences from `Prusa i3 Mk2 S3D Pristine 20171117.fff`:
    - Auto-Configure for Print Quality: Medium → **High**
    - General Settings / Infill Percentage: 30% → **100%**
    - Layer / Primary Layer Height: 0.10 mm (100µm) → **0.08 mm (80µm)**
    - Layer / Outline/Perimeter Shells: 2 → **3**
    - Layer / First Layer Speed: 50% → **30%**
    - Additions / Skirt layers: 2 (orig setting)
    - Additions / Skirt Offset from Part: 4.00 mm → **0.00 mm**
    - Additions / Skirt Outlines: 2 → **10**
    - Infill / External Fill Pattern: Rectilinear → **Concentric**
    - Temperature / Primary Extruder T0: 1:200 → **1:220** (ColorFabb advises 210–230)
    - Temperature / Heated Build Platform T1: 1:60 → **1:60** (ColorFabb advises 50–60)
      This is a provisional setting to get the print to "stick" in a chilly room
    - Speeds / Default Printing Speed:
      2400 mm/min (= 40 mm/sec)
      → **3000 mm/min** (= 50 mm/sec) (ColorFabb advises 40–60 mm/sec)
      With all default under-speed settings of 80%, the actual print speed works out to 32 mm/sec. Setting the speed to 3000 with the 80% under-speed gives a net speed of 40 mm/sec.
    - Advanced / Movement Behavior / Avoid crossing outline for travel movements: OFF → **ON**
  - Build Processes
    - `Bird`, `BodyDist`, and `BodyProx` processes, all with the Profile above
    - In each process, use [Select Models] (lower left) to select corresponding models.
  - Positioning 3 components on the build plate for **individual printing** on the Prusa i3 Mk2:
    - `Bird`: [120, 90]
    - `BodyDist`: [150, 105]
    - `BodyProx`: [95, 105]
  - Click [Prepare to Print]
    - Process Selection: Select just the `BodyProx` component / process
    - Printing Mode: Continuous printing: layer-by-layer
- Predicted build stats: Time: 6h 25m, Filament length: 15.821 m, Plastic weight: 47.57g (0.10 lb)
- Printer: Pi2Mk2/FCMG, 0.40mm brass E3D nozzle
- Filament: ColorFabb CorkFill 1.75mm; Processing Temp: 210–230°C.

- Live settings:
  - Nozzle temperature: 220°C
  - Build plate temperature: **60°C**
  - Speed: 100%; Material Flow: 100%



Results: ***Locked out of the club***.

Had to get the Kevo app loaded onto my iPod and iPad, and get a key transfer from Vladamir.

Took all day.

Prusa i3 Mk3 Printer

Ordered Original Prusa i3 MK3 3D Printer on 11/19/2017 … $999, plus 3 replacement extruder nozzles (0.50, 0.40, 0.25 mm) from Pursa.com …

> PREORDER! We expect to start shipping in late November! New orders to be shipped in January 2018!

With $100 shipping, total $1,024.71. Order number 2017275759. “exterior dimensions 42 × 42 × 38 cm (16.5 × 16.5 × 15 inches)”

> Chat on 11/28/2019:
>
> CLINT: Hi Folks ... hate to be a pain, but I ordered an i3 Mk3 10 days ago, and I want to confirm all is AOK and I am in the queue. Order reference is 2017275759
>
> BART: everything ok, your order will be shipped in late january
>
> CLINT: Excellent! Thank you SO MUCH

Breath Flute #69 – Improvements 11/19–20/2017

Issues addressed:

- Introduced an ExtruderWidth parameter, for use in situations where elements should be an integral multuiple of the Extruder Nozzle size. Done.
- Increased ramp thickness to ExtruderWidth*3 (if no inset letters) and ExtruderWidth*4 (if no inset letters). This amounts to an increase from 1.40 mm to 1.60mm with inset lettering. Done.
- Add Inlay Channels for inlay veneers purchased from the Woodworker’s Club – Sauers & Co. item 187-006-2, $\frac{3}{16}$″ × $\frac{1}{28}$″ × 36″ (two), White Maple and Mahogany. ***This was complicated!*** Done.
- Introduce a FlangeBias factor to cure a tiny overhang tiny overhang “shelf” at the proximal end of the flare bevel. The overhang appears in the `BodyProx` part, and could possibly block full insertion of the `BodyProx` tenon into the `BodyDist` mortice / sleeve. This factor “widens” the bevel angle at the proximal end to very slightly shorten the bevel. It ***must*** be applied in both `SplitBodyShape*()` routines. Done.
- Add a new a FlangeBias factor to cure a tiny overhang tiny overhang “shelf” at the proximal end of the flare bevel. The overhang appears in the `BodyProx` part, and could possibly block full insertion of the `BodyProx` tenon into the `BodyDist` mortice / sleeve. This factor “widens” the bevel angle at the proximal end to very slightly shorten the bevel. It ***must*** be applied in both SplitBodyShape*() routines. Done.
- Add an fnText for the $fn settings on text () generation. Done.
- Convert printing of the date on the ramp to Arial Narrow Bold rather than Chianti. Allows room for the full YYYY year to be printed. Done.

- Maybe in the future, make the sides of the flange that joins the `BodyProx` to the `BodyDist` components not square, but at a similar axis to the sides of the flue. This will probably interfere with the printing of "Breath Flute" on the side …

11/20/2017 Print of BodyDist: CorkFill, FCMG Pi3Mk2

Print of one component using a prior profile, 80µm layers, 100% infill, at 3000 mm/min:

- Printed: November 20, 2017
- Source: `BFlute_069.scad`
- STL: (these are the Round 3 or subVersion 3 files):
- `BFlute_069_20171120_Bird_Valid_HiRes.stl` (516 KB)
- `BFlute_069_20171120_BodyDist_Valid_HiRes.stl` (5.9 MB)
- `BFlute_069_20171120_BodyProx_INValid_HiRes.stl` (30.7 MB)
- Factory: `BFlute_069_20171120_All3_S3D_Pi3m2_Ckfill_80um_100pct_3000.factory`
- Profile: `Pi3m2 Corkfill 80um 100% 3000 20171119.fff`
- Based on:
- G-code: `BFlute_069_20171120_Bird / BdDist / BdProx_S3D_Pi3m2_Ckfill_80um_100pct_3000.gcode` (65.5 MB)
- Slicer: Simplify3D 4.0.0
  - Three STL file models were left in their default import locations
  - Each model tied to its correspondingly named process
  - Click [Prepare to Print]
    - Process Selection: Select just the `BodyDist` component / process
    - Printing Mode: Continuous printing: layer-by-layer
- Predicted build stats:
  - `Bird`: Build time: 2h 37m, Filament length: 2.040 m, Plastic weight: 6.13g (0.01 lb)
  - `BodyDist`: Build time: 6h 40m, Filament length: 16.125 m, Plastic weight: 48.48g (0.11 lb)
  - `BodyProx`: Build time: 6h 26m, Filament length: 15.835 m, Plastic weight: 47.61g (0.10 lb)

Could not start print on the Pi3Mk2/FCMG because of clogging. Produced G-code on-site for the UM2+, but had the same problem as before – failed first layer, which I now attribute to a clogged extruder.

> Need to learn basic maintenance on these devices!

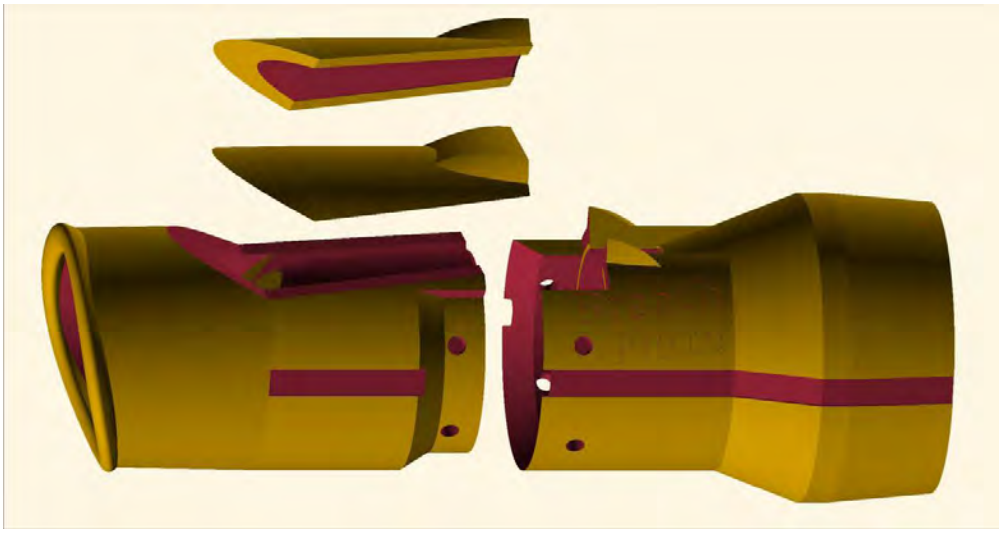
Breath Flute #70 – Improvements 11/21/2017

Issues addressed:

- Make the sides of the flange that joins the `BodyProx` to the `BodyDist` components not square, but at a similar axis to the sides of the flue. This is dauntingly difficult to implement … a modification to the `centerWedge()` at the end of the `SplitBodyShapeForBodyProx/Dist()` routines would be needed that allows different "d" settings for the top and the bottom. The `centerFWedge()` routines

allow a flared wedge – i.e. different "r" settings. However, to implement different "d" settings would require … hmmm … a lot of head-scratching. Not done.

- The model is rendered using fonts on my system – specifically: Chianti and Arial. Rendering in OpenSCAD is not possible without these fonts (unless the source code is modified). Distributing these fonts with a source code distribution is not allowed, because these fonts are rights-restricted. To avoid this issue for any future source code distribution, I replaced all fonts referenced in the OpenSCAD source code with fonts from my Kurinto fonts (specifically: Kurinto Sans Bold and Kurinto Sans Bold Italic), which are licensed under the SIL OFL 1.1. It remains an open issue as to whether the SIL OFL 1.1 is compatible with GPL, or any other license under which the source code might be licensed (I think GPL 2 prohibits additional restrictions … which would imply an incompatibility). Done 11/22/2017. On 6/8/2018, I looked into font compatibility issues, and OFL fonts can be included in a GPLv3 project, so Kurinto fonts can be distributed. This was document in the Developer's Guide 0n 6/8/2018.



11/22/2017 Print of 3 Components in CorkFill on the FCMG Pi3Mk2

Print of one component using a prior profile, 80µm layers, 100% infill, at 3000 mm/min:

- Printed: November 22, 2017
- Source: `BFlute_070.scad`
- STL: `BFlute_070_20171122_Bird_Valid_HiRes.stl` (516 KB)
- `BFlute_070_20171122_BodyDist_Valid_HiRes.stl` (6.2 MB)
- `BFlute_070_20171122_BodyProx_INValid_HiRes.stl` (30.8 MB)
- Factory: `BFlute_070_20171122_All3_S3D_Pi3m2_Ckfill_80um_100pct_3000.factory`
- Profile: `Pi3m2 Corkfill 80um 100% 3000 20171119.fff`
- Based on:
- G-code: `BFlute_070_20171122_Bird / BdDist / BdProx_S3D_Pi3m2_Ckfill_80um_100pct_3000.gcode`
- Slicer: Simplify3D 4.0.0
  - Three STL file models were left in their default import locations
  - Each model tied to its correspondingly named process

    - Click [Prepare to Print]
        - Process Selection: Select just the `BodyDist` component / process
        - Printing Mode: Continuous printing: layer-by-layer
- Predicted build stats:
    - `Bird`: Build time: 2h 37m, Filament length: 2.040 m, Plastic weight: 6.13g (0.01 lb)
    - `BodyDist`: Build time: 6h 40m, Filament length: 16.125 m, Plastic weight: 48.48g (0.11 lb)
    - `BodyProx`: Build time: 6h 25m, Filament length: 15.832 m, Plastic weight: 47.60g (0.10 lb)

11/22/2017 Print of 3 Components: CorkFill on the UM2+/FCMG

Print of one component using a prior profile with 80µm layers, 100% infill, at 2500 mm/min:

- Printed: November 22, 2017
- Source: `BFlute_070.scad`
- STL: `BFlute_070_20171122_Bird_Valid_HiRes.stl` (516 KB)
- `BFlute_070_20171122_BodyDist_Valid_HiRes.stl` (6.2 MB)
- `BFlute_070_20171122_BodyProx_INValid_HiRes.stl` (30.8 MB)
- Factory: `BFlute_070_20171122_All3_S3D_UM2p_Ckfill_80um_100pct_2500.factory`
- Profile: `BFlute UM2p Ckfill 80um 100% 2500 20171120.fff`
- Based on:
- G-code: `BFlute_070_20171122_Bird / BdDist / BdProx_S3D_UM2p_Ckfill_80um_100pct_3000.gcode`
- Slicer: Simplify3D 4.0.0
    - Three STL file models were left in their default import locations
    - Each model tied to its correspondingly named process
    - Click [Prepare to Print]
    - Process Selection: Select just the `BodyDist` component / process
    - Printing Mode: Continuous printing: layer-by-layer
- Predicted build stats:
    - `Bird`: Build time: 2h 39m, Filament length: 0.729 m, Plastic weight: 5.82g (0.01 lb)
    - `BodyDist`: Build time: 8h 45m, Filament length: 5.771 m, Plastic weight: 46.02g (0.10 lb)
    - `BodyProx`: Build time: 8h 28m, Filament length: 5.619 m, Plastic weight: 44.81g (0.10 lb)

Jon suggested a paint to fill the lettering by email … need to check out. (this was addressed in #71)

Met with Vladimir. He suggested that Corkfill is the cause of the jamming. Try regular PLA. Reset to use MakerGeeks Maker Filament 1.75mm Dark as Night Black with a suggested print temp of 230°C.

By changing print temp to 230

This failed … would not stick to bed

Vladimir suggested that the Min height for first layer is 0.20mm or greater (0.30 would be good)

Reset to:

Layer → First Layer Settings → First Layer Height: 150% to **250%**

Created `BFlute Pi3m2 MgPLA 80um 100% 3000 20171122.fff` by modifying `BFlute Pi3m2 Corkfill 80um 100% 3000 20171119.fff`

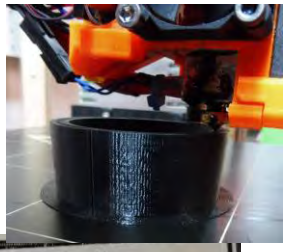
G-Code: `BFlute_070_20171122_BodyDist_S3D_Pi3m2_MgPLA_80um_100pct_3000.gcode`

Factory: `BFlute_070_20171122_All3_S3D_Pi3m2_MgPLA_80um_100pct_3000.factory`

- `BodyDist`: Build time: 6h 39m, Filament length: 16.156 m, Plastic weight: 48.58g (0.11 lb)

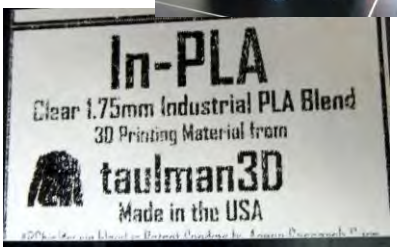
Overnight Print failed – Thermal runaway!

Read Prusa on-line documentation / advice (see saved DOCX). Also emailed Valdimir with pic. Prusa doc suggested that one of the issues causing a thermal runaway is a high temp print in a cold environment. Other issues are fan speed. (also many other causes, mostly beyond me).



Decided to go to a PLA-only, 1.75mm material with a suggested temp of 210 or below, with a spool that fits the arms on the Prusa (larger MakerBot spools don't fit prusa).

MakerBot PLA spools have no specs (neither on the spool, nor online). MakerGeeks all had high temps – the transparent PLA flavors specify 235°C. Decided to use (pretty much the only suitable choice in the club): Taulman3D In-PLA 1.75mm Clear



See `Taulman3d_InPLA_Specs_8959508_orig.jpg`

Created `BFlute Pi3m2 InPLA 100um 100% 2400 20171123.fff` from `BFlute Pi3m2 MgPLA 80um 100% 3000 20171122.fff`

Temp 210

First layer 200%

Layer height 100 um

Primary speed: 2400 (original setting of the Pristine)

Physical Properties	Units	Std PLA	In-PLA
Specific Gravity	g/cm3	1.25	1.243
MFR	g/10min	16.6 (210°C /2.160kg)	4.10 (210°C /2.160kg)
Mechanical Properties			
Ult. Tensile Strength	ksi	8.9	10
Tensile Modulus	ksi	509	539.7
Tensile Strain at Break	%	3	3.5
Notched IZOD Impact	ft-lb/in	2.5	2.8
Gardner Impact	ft-lb	0.22	0.17
Flexural Modulus	ksi	479	488.2
Deflection Temp (@264psi)	°C	49	56
Vicat Point (|®50N@120°C)	°C	50	66
Glass Transition	°C	54	65
Print Temp	°C	190	210
Optical Transmission	%	52	90

Taulman3D In-PLA Specs

NEW naming plan:
Bflute_070_CG/JN/FR125m/s/n{otherVariantIndicatorss]_B/D/P_yymmdd.stl

Design ("BFlute"),

Version NNN[letter],

Variants:
Imprint – CG=Clint Goss, JN=Jon Norris, FR=Free distribution **
Size indicator
Inlay Variant: small, medium, none,

Component: Bird, BodyDist, BodyProx _

Date of generation: optional yymmdd for sanity.

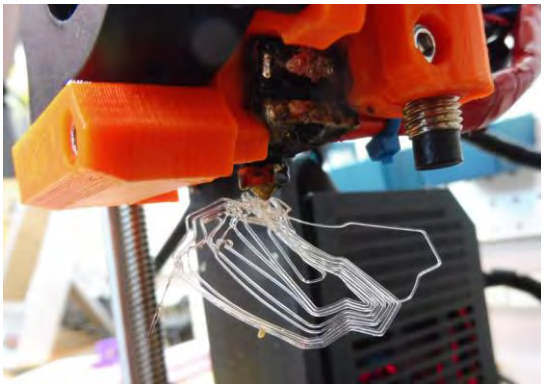
** Note that on 7/2/2018, the code for "Free distribution" was changed to "BF".

G-Code:
`BFlute_070_20171123_Bird/BodyDist/BodyProx_S3D_Pi3m2_InPLA_100um_100pct_2400.gcode`

Factory: `BFlute_070_20171123_All3_S3D_Pi3m2_InPLA_100um_100pct_2400.factory`

- `Bird`: Build time: 2h 7m, Filament length: 2.055 m, Plastic weight: 6.18g (0.01 lb)
- `BodyDist`: Not done Build time: 6h 39m, Filament length: 16.156 m, Plastic weight: 48.58g (0.11 lb)
- `BodyProx`: Build time: 6h 39m, Filament length: 16.156 m, Plastic weight: 48.58g (0.11 lb)

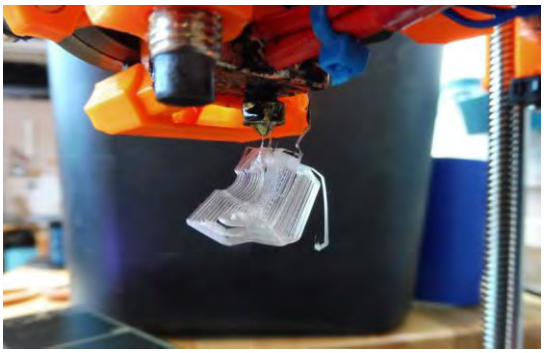
Print of bird started at 7:13 – failed – first layer would not stick and extruder dragged it up.



Material does not extrude straight down from the nozzle – it curls up, sometimes connecting with another part of the hotend – indicating a partial clog??

Tried the E-string wire by unloading filament and sending the e-string through the top and running it up and down a few times.

Second print of bird started at 7:22. Going better. Some issues with the outermost perimeter of the first layer, but it proceeded on up. … but then failed at around the 3rd layer – the whole print was dragged up onto the extruder.

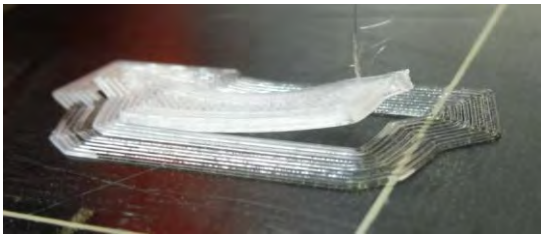


Cleaned the bed with 70% Isopropyl Rubbing Alcohol based on suggestions in the Prusa manual – two good scrubs using toilet paper (only thing available).

I also move the room heater close to the front of the printer to try to counteract chilly ambient room temp.

Print of bird started at 7:49

Bed adhered nicely! But then … a new issue: the center of the print – inside the brim – began curling up at a severe angle.



Yikes!

Stopped the print.

Online (https://www.thingiverse.com/thing:2522819) suggests that insufficient cooling is an issue – maybe the room heater was a bad idea.

See also https://www.makerbot.com/media-center/2011/06/23/12-ways-to-fight-warping-and-curling

Another idea is that the left side of the part is printing right over one of the two bolts under the PEI sheet near the center of the build plate – could the part be subject to uneven bed temperatures?

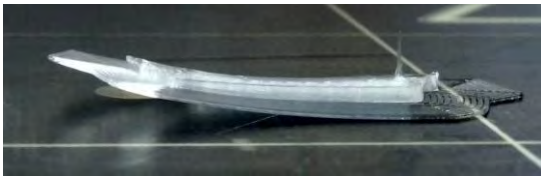
Reworked the profile to set First Layer height to 250% (250 um) and First Layer Speed 30% → 20%.

Created `BFlute Pi3m2 InPLA 100um 100% 2400 20171123a.fff`

G-Code:
`BFlute_070_20171123a_Bird/BodyDist/BodyProx_S3D_Pi3m2_InPLA_100um_100pct_2400.gcode`

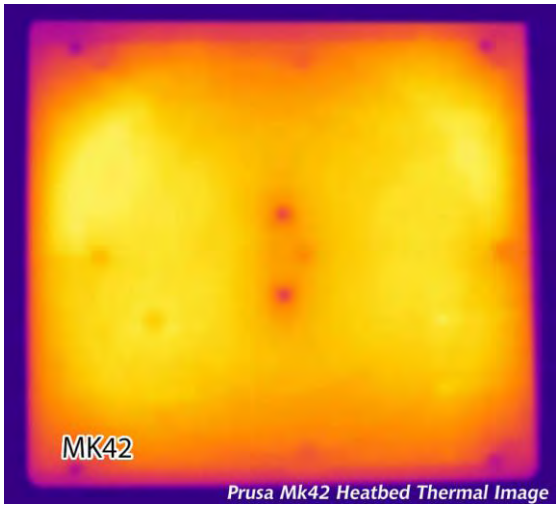
Factory: `BFlute_070_20171123a_All3_S3D_Pi3m2_InPLA_100um_100pct_2400.factory`

- `Bird`: Build time: 2h 8m, Filament length: 2.063, Plastic weight: 6.20g (0.01 lb)



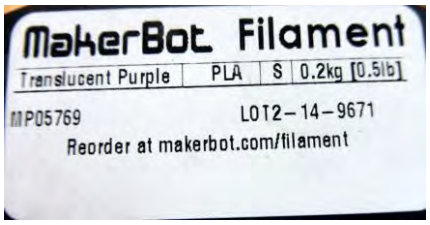
Print failed – full curling of the printed part – stopped at about the 6th layer.

Put in a query on the Prusa Forum at https://shop.prusa3d.com/forum/ under the "Original Prusa i3 MK2" board: "Do buildplate bolts affect heating?", but got a lot of replies about how to stop curling and get the print to stick, not about the bolts per se. Then I found a thermal image of the Mk42 Heated Build Plate at https://www.prusaprinters.org/original-prusa-i3-mk2-release/ which clearly shows a lower temperature around the bolts.



From Vladimir:

"Don't try this with the Taulman PLA. They are not easy to work with. Just stick with regular pla besides Taulman and Makergeeks. I'll probably sort out all the pla and put all the finicky ones in a separate container to avoid future frustration."



Next trying MakerBot Translucent Purple PLA. Specs or temp provided on the label or on the Web. Printing with the `BFlute Pi3m2 InPLA 100um 100% 2400 20171123a` profile and the same gcode file:

`BFlute_070_20171123a_Bird_S3D_Pi3m2_InPLA_100um_100pct_2400.gcode`

Print started at 10:03

Printer Enclosure: http://robertsojak.com/3d-printing/diy-3d-printer-enclosure-my-build-part-2

And https://www.reddit.com/r/3Dprinting/comments/5rhtcr/ikea_lack_enclosure_for_prusa_i3_mk2/

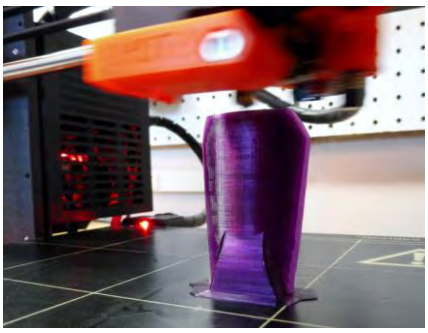
Prusa firmware upgrade?

Larger arms for Prusa for bigger rolls

External triangular filament cradle?

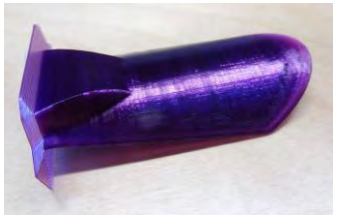
Wire brush for cleaning nozzle

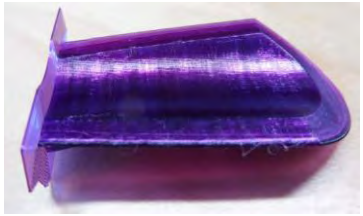
Need tools – dental floss (prusa manual), spatula with *rounded* corners (prusa manual). Needle nose



Print is *WORKING* … so generated the `BodyDist` and `BodyProx`:

- `BodyDist`: Build time: 6h 32m, Filament length: 16.180 m, Plastic weight: 48.65g (0.11 lb)
- `BodyProx`: Build time: 6h 24m, Filament length: 15.874 m, Plastic weight: 47.73g (0.11 lb)



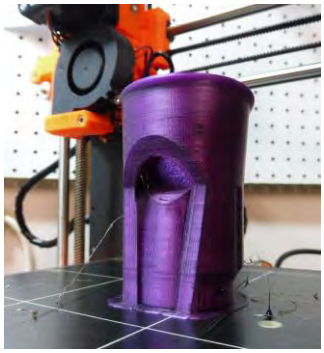


Started `BodyDist` print in MakerBot Translucent Purple PLA at 12:30PM

Print picked up 11/24/2017 at 9AM … it worked!

Printed BodyProx with same parameters.

Print picked up 11/24/2017 at 6PM … it worked!



November 25, 2017

Needed to remove the brim at the bottom of the BodyProx, which is a problem … it gets in the way of insertion and has to be carefully filed off. It also destroys the bevel at the distal end of the flue on the bottom of the flue. Should really print the BodyProx with no brim.

Assembled with two 6-23 screws from the garage. They are 3/8″ – too long for the designed holes, but the diameter and thread density work perfectly!

Ordered Fastenal SKU 25116 #6-32 × ¼″ Hex Drive Flat Point Black Oxide Finish Alloy Steel Socket Set Screw – package of 100 from https://www.fastenal.com/products/details/25116. Also SKU: 26509 1/16″ Hex Drive Rock River® Long Arm Standard L Hex Key. Order confirmation WWWN3T512WC3G.

Added lacing cut from ArtMind Leather Lace Ivory spool: 37″ gives 6 total wraps plus two short tails after a simple overhand knot. Lacing requires about 5½″ (14.0 cm) per wrap.

Sound is not bad, but not great – not really good enough for use with participants.

Sanded the top of the flue (bottom of the Bird) with 220 grit, using my index finger. Took 2-3 minutes. Nicely smooth, and sound noticeably improved. Then sanded the bottom of the flue on the BodyProx component using a combination of the 220 grit sandpaper and index finger, plus the most coarse micro-mesh buffing stick – the rust-colored #1500 (= #400 grit sandpaper, according to their chart).

> Criteria for "smooth-sanding": sand until you no longer feel ridges when you run your fingernail across the surface perpendicular to the orientation of the filament layers.

Nice and smooth, and the sound again noticeably improved.

> It's clear that the flue on all 3D-printed Breath Flutes will require sanding.

The sound of v70 does not have rich overtones when compared with the Peter Riley prototype. It also uses much more air – maybe double. Sighting down the flue of v70 it appears noticeably fatter (vertically) than the Peter Riley prototype … need to measure with feeler gauges! The flat surfaces where the `BodyProx` component mates with the Bird may need sanding.

November 26, 2017

Current setting in the v70 source code are:

```
// Flue Depth at the distal end
FlueDistDepth = 1.2;
```

Measurement of the depth of other flutes at the distal end:

- PRF (the Peter Riley prototype): 1.29 mm, 1.18 mm, and 0.96 mm at the (player's) Left, Center, and Right sides, respectively. Measured 2/8/2017 using feeler gauges.
- The N20 (Jon Norris prototype) is 2.00 throughout, measured 2/8/2017.
- V35m = 1.75 throughout, measured 2/8/2017
- V36S = 1.813 measured 2/8/2017

The actual (measured) depth of the distal end of the flue on V70 using the feeler gauges and the Brown & Sharpe calipers is 0.0513″ (= 1.303 mm) in the center. Slightly less on the player's right and slightly more on the player's left.

Smooth-sanded the base of the bird using 220 grit on a flat block of wood – easily sanded the two "rails" smooth. It was a bit more troublesome for the smaller, angled, U-shaped "rail" at the top – hard to keep a steady angle.

> Consider a tool that helps you sand the bird, especially the top u-shaped Rail at the top, at a given angle.

Also smooth-sanded the rails on the `BodyProx`. This is challenging and problematic! The floor of the flue actually bumps up above the rails. If they did not, one could sand straight across both flat rails. One could even have a sanding block with exactly the same angle as the rails, so they could be sanded horizontally, and even sand the proximal face of the small "hooks" that stick up on the `BodyDist` component.

(see the ***Flue Floor*** item in the next V71)

The depth of the distal end of V70 flue is now 0.0433″ (= 1.100 mm) in the center.

Sound is noticeable better, although still not on par with PRF. I'm thinking that this would be usable for participants at a workshop. Maybe the splitting edge is not sharp enough? (hard to tell).

Vera's Evaluation

Did a blind test for Vera of PRF versus V70, as currently processed and sanded. A real eye-opener.

My preference in sound for the breath flute is heavily influenced by the fujara … and this preference is likely to have been cultivated by the community of fujara players I have known. More overtones, more registers, deep and rich and complex low tones, and bright high tones. This is PRF.

V70 is somewhat quieter, currently uses somewhat more breath, and has a less "complex" sound – fewer registers are achievable, and the tone across the range is less bright. If it were a fujara, the advice might be "getting close, but not there yet".

Vera's listened to both in a blind A / B setup and … she much (much) preferred V70. She was thinking of a group music setting, with lots of Breath Flutes playing, etc. She though PRF was sharp, annoying, grating. V70 was "round and wholesome".

Interesting …

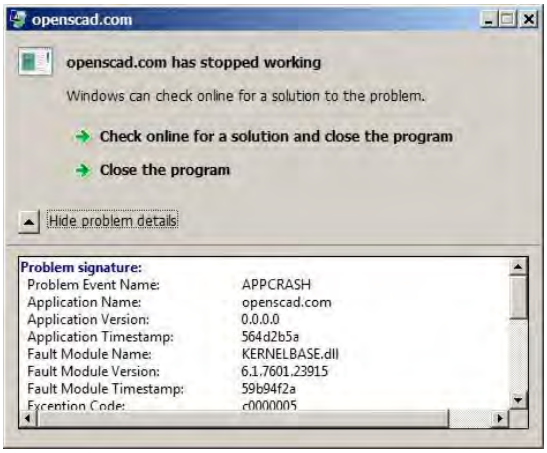
Breath Flute #71 – Improvements Beginning 11/27/2017

The issues addressed are extensive …

Render Scripts

- Develop a command-line (script-based) approach to rendering OpenSCAD files to STL.

New scripts developed in the new `/Gen` subdirectory.



Attempted to use the `gen.pl` scripts from Flutopedia. Rather challenging with all the escape characters and double-double quotes. Got it running, but OpenSCAD, when run by a back-quote from Perl, gets a Windows dialog box that it has "Stopped working". It then (eventually, after eating over 10GB of main memory) exits. This stillborn effort is in the `/Gen/Ver1_PerlBasedScripts` subdirectory.

Running the commands in a Windows `.BAT` file does seem to work, but has disadvantages: much more difficult to save a log file, and not so easy to call a subroutine for each invocation of OpenSCAD. However, this seems to be the only choice.

Attempted numerous configurations of two Windows `.BAT` files to achieve logging. Numerous failures and application crashes. Finally gave up. This stillborn effort is in the `/Gen/Ver2_BatchFilesWithLogging` subdirectory.

The thing that worked is a straightforward, but "non-programmatic" list of direct commands with no redirection and no logging.

Procedure for rendering all needed STL files:

- Navigate to `/BreathFlute/Gen`.
- Open a ***new*** Command Prompt using the `CommandPromptForRender` shortcut.
- In the new command window:
  - Edit `render.bat` as needed to select the components to be rendered.
  - Run `render.bat`
  - Copy _RenderAll.docx (the prototype LOG document) into a `NEW.docx`
  - Command → Edit → Select All
  - `Enter` (this executes Command → Edit → Copy)
- Paste the copied text into the `NEW.docx` file to document the results of the Render.

The `CommandPromptForRender` shortcut has these options:

- Shortcut
  - Target: %windir%\system32\cmd.exe

    - Start in D:\BreathFlute\Gen
- Options
    - Cursor: Small
    - Buffer size: 50
    - Number of buffers 4
    - NO Discard Old Duplicates
    - NO QuickEdit
    - Yes Insert Mode
- Font: Consolas 14 NO Bold
- Layout:
    - Screen buffer size: 999 wide × 9000 high
    - Window size: 200 wide × 44 high
    - YES Let system position window
- Colors
    - Screen background: 0, 0, 128
    - Screen text: 192, 192, 192
    - Popup text: 128, 0, 128
    - Popup Background: 255, 255, 255

Done 11/27/2017

On 11/29/2017 the `render.bat` script and the `CommandPromptForRender` shortcut were re-located to the `/CGModels` directory! This facilitates development and backups of these items.

Logging

- Add a new `LogMode` parameter to control whether output of logging info is to HTML or Text.

By default, log output is done in `HTML` because the GUI render window displays HTML. However, for command/script based logging, it's set to `Text` for text-only log output.

Done 11/27/2017

Imprint

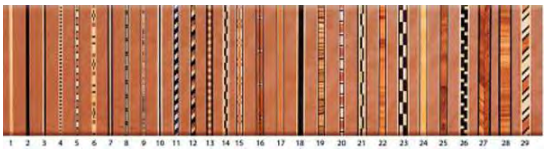
- Add two-letter designations for the "Imprint" – indicating who is printing that are printed on the side, or at least the source of the `STL` file: `CG`, `JN`, and `FR` ("Free" – on 7/2/2018 this code was changed to `BF`). This is one of the items in the "variant" flags for the `STL` file.

Done 11/27/2017

Inlay

- Add options for various sizes of inlays

Implement a one-character flag that indicates the width of any channels for inlay strips on the sides of the components. Note that the designation affects both the width and the thickness of the inlay. The parameter is "n" for none, or a single digit with the number of sixteenths of an inch for the nominal width of the inlay channels.



See Sauers & Company products at http://SVeneers.com/ and https://www.Woodcraft.com

- n = No inlay channels
- 1 = 1/16" inlay: No Sauers products
- 2 = 1/8" inlay: Sauers #1-4
- 3 = 3/16" inlay: Sauers #5-10
- 4 = 1/4" inlay: Sauers #11-18
- 5 = 5/16" inlay: Sauers #19-22
- 6 = 3/8" inlay: Sauers #23-26
- 7 = 7/16" inlay: No Sauers products
- 8 = 1/2" inlay: Sauers #27-29

Done 11/27/2017

Material

- Add an option for the various material choices.

This controls things like the expected Shrinkage Factors. Note that CASE is SIGnificant! Upper case are specific filament products. Lower-case are generic materials.

- a = ABS (generic)
- p = PLA (generic)
- C = Corkfill (ColorFabb)
- N = nGen (ColorFabb) – Amphora AM3300.

Done 11/27/2017

STL Naming Convention

- Develop and document a naming convention for STL files.

Done in the `render.bat` script, and documented in there … will likely change a bit over time.

Done 11/27/2017

PLA Shrinkage factor

- Change shrinkage factor to that of PLA … needs to be measured!
- Use the shrinkage factor to adjust the actual printed size of the inlay channels.
- Use the shrinkage factor in the calculation of the size of the peg holes.

The PLA model of v70 printed with Corkfill settings for shrinkage (X=0.79, Y=0.90, Z=1.43) and the mortice at the distal end was a bit too large. This is odd, because published PLA shrinkage factors run around 2%.

Resetting all PLA shrinkage factors from 2.00% to 0.50%.

Inlay channel widths now use YAFF (yet another fudge factor) to make them slightly wider, regardless of the shrinkage factor. And the peg holes work AOK as it is.

Done 11/27/2017

Burning of v70 translucent purple PLA

- Look into why the translucent purple appeared to burn at the inflection points / sharp edges.

Posted on the Prusa forum:

> Hoping more experienced folks can quickly give an opinion on the cause of the blackened filament at the sharp corners of the print …
>
> Is this burned ... or what might it be? Filament is MakerBot PLA Transparent Purple. Print temp was 210 – at the top end of recommended print temp for this material.
>
> There's also the globs and strings. I'm guessing my extrusion rate needs to be reduce, or increased retraction distance, or some such ... or maybe that is temperature as well.

Flue Floor

- Change the model so that the floor of the flue on the `BodyProx` component is always below the flat rails on which the Bird component seats. This would facilitate sanding of the flat rails as well as the proximal end of the Bird.

This appears not to be completely feasible, because the distal end of the flue floor itself sticks up above the side rails, and this cannot be changed (or it would screw up the `FlueDistDepth` setting). However, the "gradualness" or how quickly the floor of the flue rises was adjusted by changing the `LastX` parameter in ***both*** the `FluteCavity()` and `FlueWalls()` routines from 6 to 3. The floor of the flue, which was above the rails for maybe 90% of the length of the flue, is now raised above the rails for less than 50%.

This would allow:

- A sanding tool for the rails that bridges the two rails up at the proximal end of the flue bed, keeping both sides level

- A tool that has the same angle as the rails for the bird, which can be used to sand crosswise across the `BodyProx` component in order to sand the U-shaped rails at the proper angle.

I hope this doesn't change the sound of the flute!

Done 11/27/2017

Bird Bed Angle

In order to construct sanding tools for the bed of the Bird component (the "Bird Bed", consisting of numerous "Rails") … we need to know the angle between the straight rails and the U-shaped rails.

This would appear at first to be the OpenSCAD parameter `ComponentProxAngle`, but that is not so! Setting that parameter to 90 (degrees) demonstrates that the result is not a 90° angle … because of the additional `ComponentProxFudge` parameter. The angle is determined by these three Cartesian points, taken from the `BodyComponentPoints` vector:

		X (2nd vector element)	Y (3rd vector element)
Endpoint 0	[p0]	-(cos(FlueDistAngle/2) * FlueDistTRadius-Smidge) * FlueDistTRadius+Smidge for BirdComponentPoints vector	FlueDistStation-Smidge2
Vertex	[c]	-(cos(FlueProxAngle/2) * FlueProxTRadius-ComponentProxFudge)	FlueProxStation
Endpoint 1	[p1]	-ComponentFar	FlueProxStation + ComponentFarLengthAddition

Using code added to `BodyComponentPolygon()` and `BirdComponentPolygon()`, the calculated angles are:

`BodyComponentPolygon` Valley Bed Angle: 59.9371°

`BirdComponentPolygon` Valley Bed Angle: 59.9072°

Component Names

Considered a name change to allow shorter phrases and single-letter component tags:

- `Bird` → `Totem` (T)
- `BodyProx` → `Prox` (P)
- `BodyDist` → `Dist` (D)
- `Body` (B) OK
- `Headjoint` (H) OK

Shorthands:

- H = T + B(=P+D)
- `Headjoint` = `Totem` + `Body` (=`Prox` + `Dist`)

… but abandoned this idea … single-letter component tags are probably a bad idea, because they are difficult (even for me) to remember and keep straight. And … we'll be getting into a number of additional component names with the sanding blocks.

So, the standard names and tags remain: `Headjoint` (HJ), `Bird` (BI), `Body` (BY), `BodyProx` (BP), and `BodyDist` (BD).

> `Headjoint` = `Bird` + `Body` (= `BodyProx` + `BodyDist`)

Inlace

- Look into Jon's suggestion from 11/22/2017: "*Check Inlace for filling the lettering. It's a nylon polymer that simulates stone. Not sure if it'll get into the pores of the material though. Even just paint might work.*"

Info at http://www.inlaceonline.com/text/products/kits.html … Saved in `/Materials/Inlace`.

TBD – Woodcraft is a supplier, so check out The Woodworker's Club in Norwalk.

Also have crushed stone from Pasadena!

BodyProx Brim

- Eliminate the brim on the `BodyProx`. It is difficult to remove completely – requiring filing – and the distal edge of the floor of the flue gets messed up – that bevel is literally covered up by the brim.

TBD in the Slicer.

Sanding Tools

- Begin development of specific 3D-printed tools to assist in finishing and sanding Breath Flutes:
  - A cylinder for the inside of the mortice at the foot of the `BodyDist` component.
  - A cylinder for the sound chamber on the inside of the `BodyDist` component.
  - A tube for the tenon of the flange at the foot of the `BodyProx` component.
  - A cylinder for the inside of the mortice at the head of the `BodyDist` component.
  - A specialized tool for the roof of the flue (bottom side of the `Bird` component).
  - A very specialized tool for the floor of the flue on the upper side of the `BodyProx` component.
  - Consider a tool that helps you sand the bird, especially the top u-shaped Rail at the top, at a given angle. Maybe just a block at exactly the angle where the rails meet.
  - Consider a tool for sanding the rails on the `BodyProx` component. Maybe a sanding block with exactly the same angle of the rails, so they could be sanded horizontally, and even sand the proximal face of the small "hooks" that stick up on the `BodyDist` component that stick up 90°. The block does not need to be as wide as the parallel rails are long … you could engage the top part for sanding the angled portion or slide the sanding block slightly down to avoid sanding that top part.

SandB Component

Developed the new SandB (tag "SB") component on 11/29/2017 for sanding the bottom of the bird (roof of the flue). Curvature accounts for the thickness of 220 grit sandpaper.

Note that the proximal end of the underside of the Bird actually uses a different, angled diameter than the Throat_ID parameter used as the basis of this sanding block. However, the distance is so short and the change in angle and diameter is so slight, we're not gonna sweat it.

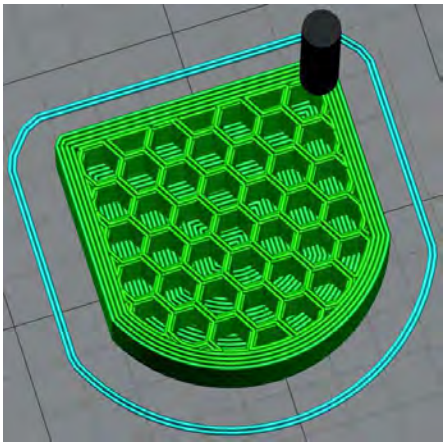
- Consider altering the slicer settings so that it does more concentric circles (rather than hash-mark infill) and does them outside to inside (this will avoid the problem of it printing a brim, then skipping to the inside of the radius and moving back to the outside to meet the brim. This might have unforeseen downsides – such as starting a new layer on the outside might cause bumps where it starts.

11/29/2017 Print of SandB in Blue MatterHackers PLA on FCMG Prusa i3 Mk2

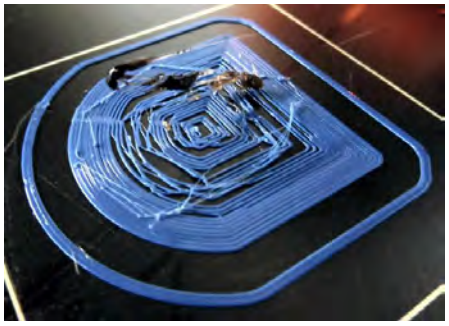
Print of the new SandB component using MatterHackers Blue PRO Series PLA 1.75mm Filament on the FCMG Prusa i3 Mk2 using **200µm Layers** and **30% infill** at **2400 mm/min**.

- Printed: November 29, 2017
- Source: BFlute_071.scad
- STL: BFlute_071_CG125pF3_SB_20171129_0831.stl (92 KB)
- Factory: BFlute_071_20171129_SB_S3D_Pi3Mk2_MhPLA_200um_30pct_2400.factory
- Profile: BFlute FCMG Pi3Mk2 MhPLA 200um 30% 2400 20171129.fff
- Based on:
- G-code: BFlute_071_20171129_SB_S3D_Pi3Mk2_MhPLA_200um_30pct_2400.gcode (4.9 MB)
- Slicer: Simplify3D 4.0.0
  - Profile differences from Prusa i3 Mk2 S3D Pristine 20171117.fff:
    - Auto-Configure for Print Quality: Medium (orig setting)
    - General Settings / Infill Percentage: 20% → **30%**
    - Layer / Primary Layer Height: 0.20 mm (200µm) (orig setting)
    - Layer / Top Solid Layers: 2 → **4**
    - Layer / Bottom Solid Layers: 2 → **4**
    - Layer / Outline/Perimeter Shells: 2 → **4**
    - Additions / Skirt layers: 1 (orig setting)
    - Additions / Skirt Offset from Part: 4.00 mm (orig setting)
    - Additions / Skirt Outlines: 2 (orig setting)
    - Infill / Internal Fill Pattern: Rectilinear → **Full Honeycomb** (for extra strength!)
    - Infill / External Fill Pattern: Rectilinear → **Concentric**
    - Temperature / Primary Extruder T0: 1:200 → **1:205**

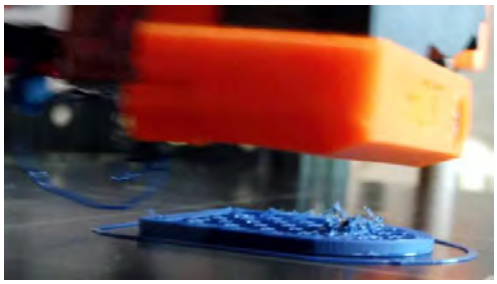
    - Temperature / Heated Build Platform T1: 1:60 → **1:55**
    - Speeds / Default Printing Speed: 2400 mm/min (= 40 mm/sec) (orig setting)
      With all default under-speed settings of 80%, the actual print speed works out to 32 mm/sec.
    - Advanced / Movement Behavior / Avoid crossing outline for travel movements: OFF → **ON**
- Predicted build stats: Time: 2h 23m, Filament length: 12.303 m, Plastic weight: 36.99g (0.08 lb)
- Printer: Pi2Mk2/FCMG, 0.40mm brass E3D nozzle
- Filament: MatterHackers Blue PRO Series PLA 1.75mm Filament. Specs:
    - Recommended Extrusion Temperatures: 205±15°C
    - Spool Dimensions (Aprox.): 200mm Total Diam × 50mm Inner Hole Diameter × 70mm Height
    - Dimensional Accuracy: ±0.05mm
    - Density: 1.25 g/cm³
    - Volume: 0.80 L
    - Length: 332.60 m

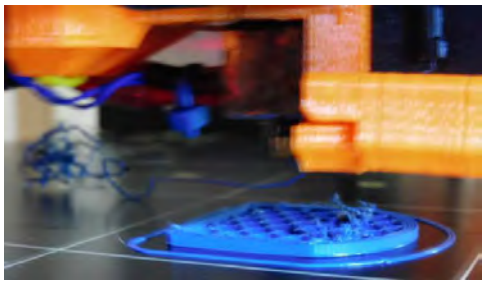


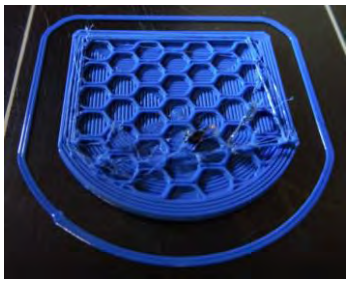
Started at 3PM 11/29/2017. First print failed badly.



Cleaned the nozzle carefully with a steel guitar high E string. Things improved for the second print …



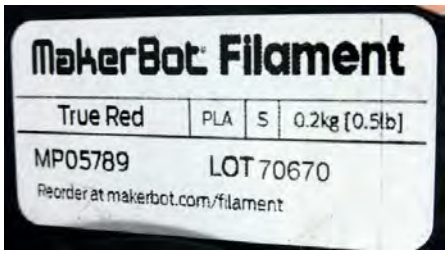




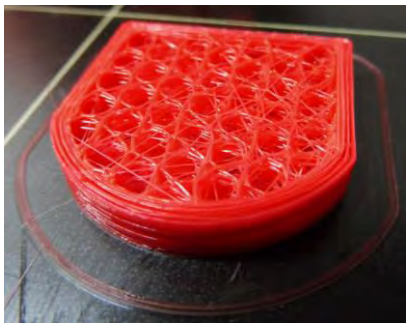
… until it failed after about 20–30 layers. Started having small problem with the print in the honeycomb section – was not perfect. Then started printing a string of mis-directed filament, then produced a ball that it just dragged around.

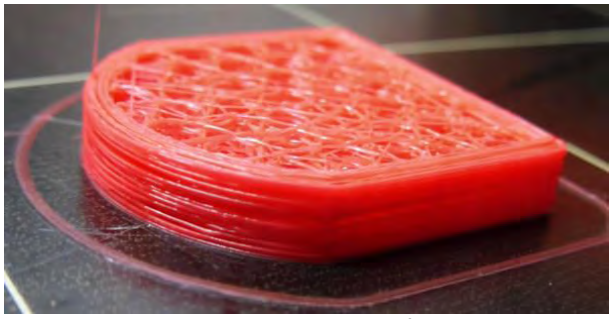
Met Michael (Rohan) R. Peck at the club, who suggested using the Form printers (https://formlabs.com/) that use SLA. Michael suggested "dental Grade resin" which is high-quality and has antimicrobial properties.

Then Vladimir showed up and overhauled the Prusa, including trying to remove the nozzle directly, then removing the fans and opening up the whole head-end, then removing the nozzle. Lots of wanderings parts and screws! Suggested using a brass Dremel brush (photo at the right) to clean the outside of the nozzle (I purchased a set the next day from Amazon).



Tried a cold pull, work with the E-string, and cleaning the nozzle from the outside, but it still exhibits an "extrude sideways" behavior. Vladimir suspected an issue with the filament, so we changed to MakerBot True Red. The third print of the SandB component was accompanied by various fan noises and grinding "grab gear" noises, and the print failed in new ways:





… Layers were not connected to each other, fragile, and stringing on the infill Full honeycomb pattern. The part is easily flexed and "crackles" when flexed. Diagnosed by Vladimir as "under-extrusion".

Vladimir confirmed that the strongest infill pattern is the Full Honeycomb.

11/29/2017 Print of 3 Components in Blue MatterHackers PLA on FCMG Prusa i3 Mk2

Planned Print of the 3 V71 components using MatterHackers Blue PRO Series PLA 1.75mm Filament on the FCMG Prusa i3 Mk2 using **100µm Layers** and **100% infill** at **2400 mm/min**.

Abandoned the idea of printing due to print failures.

- Printed: November 29, 2017
- Source: `BFlute_071.scad`
- Source: `BFlute_071.scad`
- STL: `BFlute_071_CG125p3_BP_20171128_1631.stl` (30.3 MB)
- `BFlute_071_CG125p3_BD_20171128_1631.stl` (6.6 MB)
- `BFlute_071_CG125p3_BI_20171128_1631.stl` (516 KB)
- Factory: `BFlute_071_20171129_All3_S3D_Pi3Mk2_MhPLA_100um_100pct_2400.factory`
- Profiles: `BFlute FCMG Pi3Mk2 MhPLA 100um 100% 2400 Brim 20171129.fff` (for Bird only)

- `BFlute FCMG Pi3Mk2 MhPLA 100um 100% 2400 Skirt 20171129.fff`
- Based on:
- G-code: `BFlute_071_20171129_All3_S3D_Pi3Mk2_MhPLA_100um_100pct_2400.gcode` (65.5 MB)
- Slicer: Simplify3D 4.0.0
  - Profile differences from `Prusa i3 Mk2 S3D Pristine 20171117.fff`:
    - Auto-Configure for Print Quality: Medium → **High**
    - General Settings / Infill Percentage: 30% → **100%**
    - Layer / Primary Layer Height: 0.10 mm (100µm) (orig setting)
    - Layer / Top Solid Layers: 4 (orig setting)
    - Layer / Bottom Solid Layers: 4 (orig setting)
    - Layer / Outline/Perimeter Shells: 2 → **3**
    - Layer / First Layer Speed: 50% → **30%**
    - Additions / Skirt layers: 2 (orig setting)
    - Additions / Skirt Offset from Part: 4.00 mm → **0.00 mm (1.00 for the SKIRT Profile)**
    - Additions / Skirt Outlines: 2 → **10**
    - Infill / Internal Fill Pattern: Rectilinear (orig setting)
    - Infill / External Fill Pattern: Rectilinear → **Concentric**
    - Temperature / Primary Extruder T0: 1:200 → **1:205**
    - Temperature / Heated Build Platform T1: 1:60 → **1:55**
    - Speeds / Default Printing Speed: 2400 mm/min (= 40 mm/sec) (orig setting)
      With all default under-speed settings of 80%, the actual print speed works out to 32 mm/sec.
    - Advanced / Movement Behavior / Avoid crossing outline for travel movements: OFF → **ON**
  - Build Processes
    - `Bird`, `BodyDist`, and `BodyProx` processes, all with the Profiles above – Skirt for `BodyDist`!
    - In each process, use [Select Models] (lower left) to select corresponding models.
  - Positioning 3 components on the build plate Close – single layer printing
  - Click [Prepare to Print]
    - Process Selection: Select all three components / processes
    - Printing Mode: Continuous printing: layer-by-layer
- Predicted build stats: Time: 15h 4m, Filament length: 34.139 m, Plastic weight: 102.64g (0.23 lb)
- Printer: Pi2Mk2/FCMG, 0.40mm brass E3D nozzle
- Filament: MatterHackers Blue PRO Series PLA 1.75mm Filament. Specs:
  - Recommended Extrusion Temperatures: 205±15°C
  - Spool Dimensions (Aprox.): 200mm Total Diam × 50mm Inner Hole Diameter × 70mm Height
  - Dimensional Accuracy: ±0.05mm
  - Density: 1.25 g/cm³
  - Volume: 0.80 L
  - Length: 332.60 m

SandR Component

- Develop a Sanding block component for the rails of the `BodyProx` component by subtracting the `BodyProx` component and the Flue Cavity from a solid block.

This was developed in the new `SandR` component on 12/6/2017.

Half-Components

- Develop a way to print parts of the model split lengthwise, for demo purposes.

Thought we could "crop" existing components in half using the slicer, but no dice! On 12/6/2017, developed five new components: `HeadjointHalf`, `BodyHalf`, `BirdHalf`, `BodyProxHalf`, and `BodyDistHalf`. All have all 3 letter tags, with an "H" as the last letter.

12/6/2017 Print of SandB, SandR, and BirdHalf in Red Rigid.Ink PLA on FCMG Prusa i3 Mk2

Print of the `SandB` component, the `SandR` component, and the `BirdHalf` component of V71 components using Rigid.Ink Red PLA 1.75mm Filament on the FCMG Prusa i3 Mk2 using **200µm layers** and **30% infill** at **2400 mm/min**. Note that RiPLA calls for cooler nozzle and bed temperatures than typical for PLA.

- Printed: December 6, 2017
- Source: `BFlute_071.scad`
- STL: `BFlute_071_CG125pF3_SB_20171206_0728.stl` (92 KB)
- `BFlute_071_CG125pF3_SR_20171206_0728.stl` (322 KB)
- `BFlute_071_CG125pF3_BIH_20171206_0948.stl` (264 KB)
- Factory: `BFlute_071_20171206_3items_S3D_Pi3Mk2_RiPLA_200um_30pct_2400.factory`
- Profiles: `BFlute FCMG Pi3Mk2 RiPLA 200um 30% 2400 Brim 20171206.fff` (for Bird only)
- `BFlute FCMG Pi3Mk2 RiPLA 200um 30% 2400 Skirt 20171206.fff`
- Based on:
- G-code: `BFlute_071_20171206_3items_S3D_Pi3Mk2_RiPLA_200um_30pct_2400.gcode` (7.1 MB)
- Slicer: Simplify3D 4.0.0
  - Profile differences from `Prusa i3 Mk2 S3D Pristine 20171117.fff`:
    - Auto-Configure for Print Quality: Medium (orig setting)
    - General Settings / Infill Percentage: 20% → **30%**
    - Layer / Primary Layer Height: 0.20 mm (200µm) (orig setting)
    - Layer / Top Solid Layers: 3 → **4**
    - Layer / Bottom Solid Layers: 3 → **4**
    - Layer / Outline/Perimeter Shells: 2 → **4**
    - Layer / First Layer Speed: 50% → **30%**
    - Additions / Skirt layers: 2 (orig setting)
    - Additions / Skirt Offset from Part: 4.00 mm → **0.00 mm (1.00 for the SKIRT Profile)**

        - Additions / Skirt Outlines: 2 → **10**
        - Infill / Internal Fill Pattern: Rectilinear → **Full Honeycomb** (for extra strength!)
        - Infill / External Fill Pattern: Rectilinear → **Concentric**
        - Temperature / Primary Extruder T0: 1:200 → **1:185**
        - Temperature / Heated Build Platform T1: 1:60 → **1:45**
        - Speeds / Default Printing Speed: 2400 mm/min (= 40 mm/sec) (orig setting)
          With all default under-speed settings of 80%, the actual print speed works out to 32 mm/sec.
        - Advanced / Movement Behavior / Avoid crossing outline for travel movements: OFF → **ON**
    - Build Processes
        - `Bird`, `SandB`, and `SandR` processes, all with the Profiles above – Skirt for `SandB` and `SandR`; Brim for `Bird`
        - In each process, use [Select Models] (lower left) to select corresponding models.
    - Positioning 3 components on the build plate Close – single layer printing
    - Click [Prepare to Print]
        - Process Selection: Select all three components / processes
        - Printing Mode: Continuous printing: layer-by-layer
- Predicted build stats: Time: 4h 27m, Filament length: 18.320 m, Plastic weight: 55.08g (0.12 lb)
- Printer: Pi2Mk2/FCMG, 0.40mm brass E3D nozzle
- Filament: Rigid.Ink Red PLA 1.75mm Filament. Specs:
    - Recommended Extrusion Temperatures: 180°C
    - Recommended Bed Temperature: max 45°C

12/6/2017 Print of BodyProxHalf in Brown Rigid.Ink PLA on FCMG Prusa i3 Mk2

Print of V71 `BodyProxHalf` using Rigid.Ink Brown PLA 1.75mm Filament on the FCMG Prusa i3 Mk2 using **200µm layers** and **30% infill** at **2400 mm/min**. Note that RiPLA calls for cooler nozzle and bed temperatures than typical for PLA.

- Printed: December 6, 2017
- Source: `BFlute_071.scad`
- STL: `BFlute_071_CG125pF3_BPH_20171206_0948.stl` (14.5 MB)
- Factory: `BFlute_071_20171206_BPH_S3D_Pi3Mk2_RiPLA_200um_30pct_2400.factory`
- Profile: `BFlute FCMG Pi3Mk2 RiPLA 200um 30% 2400 Brim 20171206.fff` (see above)
- Based on:
- G-code: `BFlute_071_20171206_BPH_S3D_Pi3Mk2_RiPLA_200um_30pct_2400.gcode` (5.6 MB)
- Slicer: Simplify3D 4.0.0
- Predicted build stats: Time: 1h 41m, Filament length: 6.783 m, Plastic weight: 20.40g (0.04 lb)
- Printer: Pi2Mk2/FCMG, 0.40mm brass E3D nozzle
- Filament: Rigid.Ink Brown PLA 1.75mm Filament. Specs:
    - Recommended Extrusion Temperatures: 180°C
    - Recommended Bed Temperature: max 45°C

12/6/2017 Print of BodyDistHalf in Red Rigid.Ink PLA on FCMG Pi3Mk2

Print of V71 `BodyDistHalf` using Rigid.Ink Brown PLA 1.75mm Filament on the FCMG Prusa i3 Mk2 using **200µm layers** and **30% infill** at **2400 mm/min**. Note that RiPLA calls for cooler nozzle and bed temperatures than typical for PLA.

- Printed: December 6, 2017
- Source: `BFlute_071.scad`
- STL: `BFlute_071_CG125pF3_BDH_20171206_0948.stl` (2.7 MB)
- Factory: `BFlute_071_20171206_BDH_S3D_Pi3Mk2_RiPLA_200um_30pct_2400.factory`
- Profile: `BFlute FCMG Pi3Mk2 RiPLA 200um 30% 2400 Brim 20171206.fff` (see above)
- Based on:
- G-code: `BFlute_071_20171206_BDH_S3D_Pi3Mk2_RiPLA_200um_30pct_2400.gcode` (6.3 MB)
- Slicer: Simplify3D 4.0.0
- Predicted build stats: Time: 1h 46m, Filament length: 7.393 m, Plastic weight: 22.23g (0.05 lb)
- Printer: Pi2Mk2/FCMG, 0.40mm brass E3D nozzle
- Filament: Rigid.Ink Brown PLA 1.75mm Filament. Specs:
  - Recommended Extrusion Temperatures: 180°C
  - Recommended Bed Temperature: max 45°C

12/6/2017 Printing at FCMG

Began with RiPLA Brown on Prusa with `BodyProx` component at 12:45PM. For some reason, it is printing at 200°C with bed at 60°C. Printing started well, but then shows evidence of under-extrusion. Stopped print ¼ of the way up the component.

Updated the two profiles with 180°C and 45°C and saved back to (for example)

Flute FCMG Pi3Mk2 RiPLA 200um 30% 2400 Brim 20171206_180C.fff with a similar name for the Factory and G-Code files.

Began re-printing at 1:20

That didn't seem to help … still under-extruding on two more failed prints.

On the last (third) RiPLA Brown print, I tried rolling the spool forward by hand, on the concern that the spool weight was draggin on the extruder.

Have photos of all 3 failures.

Reloaded the Yellow MakerBot filament that was on the printer when I arrive (and that printed three little birds largely successfully). Used the initial G-code file with the 200°C and 60°C temperature settings.

It seems to print better, but not perfect.

Big difference between the Brown RiPLA and the Yellow MakerBot Filament: the size of the RiPLA spool is huge compared to the MakerBot. This is in line with my "spool too heavy" theory.

Downloaded a fresh UM2+ profile, loaded up a hatchbox blue filament (photographed), and selected Fine in the filament for printing the wheel component of the Support structure, in

`Mark2_AxisNut_UM2p_HiQ_20171206.gcode`

Part printed nicely and the Bearing fit into the tire perfectly!

Printed all remaining parts with the same settings time 12h 48min:

`Mark2_Parts_UM2p_HiQ_20171206.gcode`

Saved factory to Mark2.factory

This proved somewhat problematic, as the first layer for the all-parts did not print well the first or second time. Vladimir helped … Had to set the layer width to Auto, changed the layer height to 0.15mm (from 0.10), and the first layer height to 150% from 200%. Also raised the bed by turning all four screws on the Ultimaker – under the Ultimaker bed "loosed" (clockwise looking from the top), to raise the bed. It worked.

First layer changed from "beadlike" and with gaps to "slightly squished" and no gaps.

Yellow printed part on the Prusa came out OK. Not great, but OK.

Measuring the filament with the new iGaging caliper: Rigid.Ink is 1.75mm spot on, while the yellow material is 1.81mm. That could be a reason for under-extrusion of the Rigid.Ink filament.

Yellow part showed clearly that the thickness of the floor of the Flue and also, to a lesser extent, the thickness of the ramp are TOO THIN. Need to fix in v72.

Changed filament to Hatchbox black and printing the other two components in the _2Parts_ Factory and G-code files, at 200°C.

2hrs predicted time.

Thought I was printing at 200, but it came out at 180 / 45. Ugh. That was because I saved the lower temps back to the profile earlier.

Adjusted temps to 200°C and 55°C live using Prusa Tune function.

Black parts finished and look OK!

Set up a print for 2 sanding components in the same black PLA, with 205°, 100um layer height.

BFlute_071_20171206_2Sand_S3D_Pi3Mk2_PLA_100um_30pct_2400_205C.factory & G-code. (11.8 MB G-code)

Predicted print time 6h 36min

12/7/2017 @ 4AM

Sanding blocks printed AOK in black!

Spool Holder printed AOK in blue!

Re-worked the Spool Holder with separate processes for wheels and other parts. Wheels have 10 perimeters, other parts have 4 perimeters. Saved (exported) all FFF and Factory files.

Predicted time 10h 42m.

`SpoolHolder_Mark2_AllParts_UM2p_20171207_v05.gcode`

`SpoolHolder_Mark2_v05.factory`

The bolts (screws) are the week spot. The heads broke off 2 out of 2 times.

Reprinted bolts only – 9 of them – in Black PLA on Prusa with 100% infill.

12/7/2017 @ 1PM

Black bolt printed on the Prusa perfectly … remove and installed to complete the first Spool Holder!

> Removed the bolts by twisting ("Twist or Shout"). Used a long-reach angle wrench to grab the base of the part from above and twist – came off instantly, when it refused to come off using a spatula.

Second spool holder on the Ultimaker in Blue warped badly on the right side of the printer (as you look at the printer). Two parts came loose (both are wheels), and two more parts (one wheel and one arm) are badly warped. Could the Ultimaker heated bed be failing on the right side??

Started print on the Prusa in black of 9 wheels and 9 bolts. 205°C and 60°C. print started at 2PM – predicted print time 10h 22m.

`SpoolHolder_Mark2_9Bolts9Wheels_Pi3Mk2_v07.gcode` and `.factory`

Started print on the Ultimaker of the remaining needed parts at 4PM – predicted print time: 11h 15m.

`SpoolHolder_Mark2_SelectedParts_UM2p_v08.gcode` and `.factory`

12/8/2017 @ 5AM

All components printed nicely (!!) … except that the blue arms on the Ultimaker curled up. This is apparently due to too high a bed temperature, according to the cheat sheet from Rigid.Ink.

Breath Flute #72 – Improvements Beginning 12/1/2017

The issues addressed are …

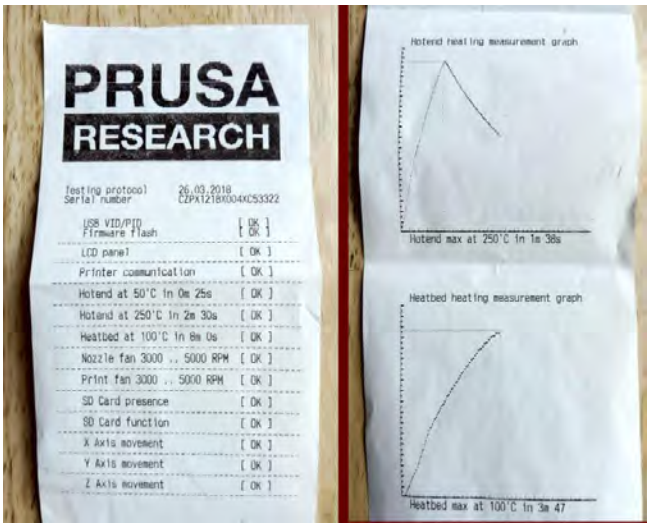
- Simplify the Shrinkage factor implementation. It is unreasonable to provide a range of different sizes for general use. People who are printing directly from STL can set a various scaling factors in their slicer! Set all shrinkage factors to ?zero? Keep the one-letter `varMaterial` tag in the name??
- Need a better spool holder / cradle for the Prusa. The stock spool holder does not handle large spools at all, causes binding on the medium-large spools of MatterHackers, and generally drags on the delivered spool, possibly causing the under-extrusion issues of v71. Located a nice design by Majewski … *DONE – printed various spool holders and use them on an overhead shelf.*
- Look into the use of cleaning filaments … eg. by Rigid.Ink or MatterHackers. *DONE – purchased some from Rigid.Ink.*
- From the printing of the `BodyProxHalf` component on 12/6/2017, it's clear that the floor of the flue needs to be thicker! Also the ramp is too thin, but not as bad as the flue floor. *DONE – increased thickness of the flue floor and ramp in April 2018.*
- The SandR component printed nicely, however:
  - The entire block is not thick enough to easily hold – it need to have more depth. *FIXED in v72.*
  - The side rails are not high enough to keep the component on-track – and the foot is not high enough to act as a stop. *FIXED in v72.*
  - It might be nice to print it so that, somehow, the sanding rails are flat rather than sloped. The sloping creates a step effect when 3D printing. This would involve canting the model at an angle – just the right angle, before subtracting it from the sanding block … another possible TNE situation. *FIXED in v72.*
- The `Bird` component needs Identification / side lettering so that birds don't get mixed up. *DONE in v72 in April 2018.*
- All components need to have the Imprint and Material indicators printed on them. *DONE in v72 in April 2018.*
- The date printed on the rendered model needs to be auto-generated from the render.bat file, not set by hand (where it could be wrong). We also need an array of date formats for different situations. Also, change ProjectDate to RenderDate. *DONE in v72 in April 2018.*
- Identify the tools (Sanding Blocks) on the tool itself. *DONE in v72 in April 2018.*
- Create a new Inset Splicer tool (`InSplice`) to precisely cut the angles for insets on the sides of the flute body. This could be done as an external model, rather than in the every-ballooning `BFlute.scad` file.
- Change the name of the `SandR` (Rail Sander) to `SandN` (Nest Sander) – much nicer. *DONE in v72 in April 2018.*
- Make all inset lettering deeper – two layers wide should be good (ie. 0.80 rather than 0.40mm). *DONE in v72 in April 2018.*

Pronunciation

Prusa is by Josef Průša. Prusa is pronounced like "proo-shah" (using Flutopedia pronunciation guide at http://www.flutopedia.com/pronunciation.htm).

4/2/2018 – Prusa i3 Mark 3 (Pi3Mk3) Printer Arrives!

… 134 days after ordering … more than 10 weeks past due date. Sigh.



Spring Steel Sheet Measurements

Measured the edges of the Spring Steel Sheet (SSS) with smooth PEI (Polyetherimide – https://en.wikipedia.org/wiki/Polyetherimide) sheet on both sides:

- 1.12mm – Back Center (between the two V-shaped notches)
- 1.12mm – Center Right
- 1.11mm – Front Right
- 1.12mm – Front Center
- 1.14mm – Front Left
- 1.11mm – Center Left

PINDA Height

Measured the PINDA height – in case the PINDA ever gets knocked around and I need to re-set it. The PINDA works out to 0.82mm above the tip of the extruder nozzle.

I used paper feeler gauges made of 24lb Staples printer paper. On-line sources (https://printing.ucr.edu/paper_thickness.html) quote:

- 20lb / 50lb offset text (uncoated) paper and 70lb gloss text coated paper at 0.0035″ = 3.5mil = 0.00889 cm = 0.0889 mm per sheet

- 24lb / 60lb offset text (uncoated) paper and 80lb gloss text coated paper at 0.004″ = 4 mil = 0.01016 cm = 0.1016 mm per sheet
- 28lb / 70lb offset text (uncoated) paper and 100lb gloss text coated paper at 0.005″ = 5 mil = 0.01270 cm = 0.1270 mm per sheet

Cleaned the nozzle (Raise Z, Unload Filament, Heat, Cleaned with brass brush) and then did Calibration → Auto Home with NO SSS installed.

Height of Nozzle: 5 paper sheets (a bit tight) = 0.50 mm

Height of PINDA: 13 paper sheets (nicely snug) = 1.33 mm (or 0.1023 mm per sheet)

Difference: 8 paper sheets or 0.82 mm.

Menu Outline

There was no source for the current menu layout, so I concocted this:

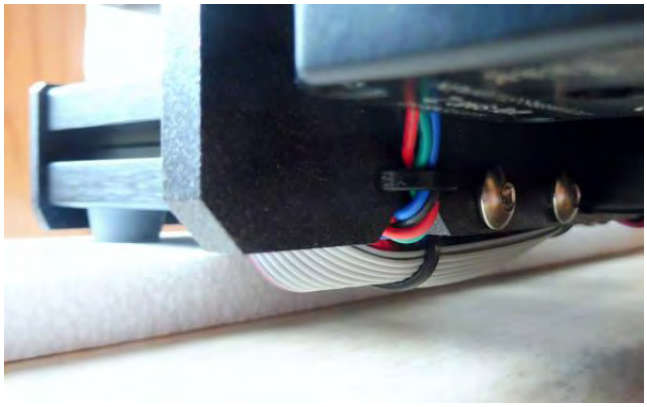
- Info Screen ↑
- Preheat
  - Main ↑
  - PLA 215 / 60
  - PET 230 / 85
  - ABS 255 / 100
  - HIPS 220 / 100
  - PP 254 / 100
  - FLEX 240 / 50
  - Cooldown
- Print from SD
  - Main ↑
  - <files …>
- AutoLoad filament
- Unload Filament
- Settings
  - Main ↑
  - Temperature
    - Settings ↑
    - Nozzle
    - Bed
    - Fan Speed
  - Move
    - Move X →
    - Move Y →
    - Move Z →

        - Extruder →
    - Disable Steppers
    - Fil. Sensor [on] [off]
    - F. autoload [on] [off]
    - Fans check [on] [off]
    - Mode [Normal] [Stealth]
    - Crash det. [on] [off]
    - Temp. cal. [on] [off]
    - RPi port [off] [on]
    - Live adjust Z →
    - Select Language
        - Settings ↑
        - English
        - Cestina
    - SD Card [Normal] [Flsh Air]
    - Sort [Time] [Alphabet] [None]
- Calibration
    - Main ↑
    - Wizard
    - First layer cal. →
    - Auto home
    - Selftest
    - Calibrate XYZ – ***NO Spring Steel Sheet for this operation!!***
    - Calibrate Z – Use a SSS for this
    - Mesh Bed Leveling →
    - Bed level correct(ion) →
        - Settings ↑ -- this is actually incorrect – it goes back up to calibration …
        - Left Side [um]: 0
        - Right, Front side [um]: 0
        - Rear side [um]: 0
        - Reset
    - PID Calibration →
        - Set Temperature: 210
    - Show End Stops →
        - End stops diag
        - X1
        - Y1
        - Z0
    - Reset XYZ valib.
    - Temp calibration
        - Calibration ↑

        - Calibrate →
- Statistics
    - Total filament: 1.97m
    - Total print time: 0d : 4h : 4m
- Fail Stats
    - Main ↑
    - Last Print
        - Last Print failures
        - Power failures 0
        - Filam. Runouts 0
        - Crash X0 Y0
    - Total
        - Total failures
        - Power failures 0
        - Filam. Runouts 0
        - Crash X0 Y0
- Support
    - Firmware:
        - 3.1.3-245
    - Prusa3d.com
    - Forum.prusa3d.com
    - Howto.prusa3d.com
    - ----------
    - 1_75mm_MK3
    - EINY_04a
    - E3Dv6full
    - ----------
    - Date:
    - Mar 9 2018
    - ----------
    - XYZ cal. Details
        - Y distance from min
        - Left: 10.75mm
        - Right: 10.86mm
        - Measured skew: 0.06°
        - Slight Skew: 0.12°
        - Severe skew: 0.25°
    - Extruder info
        - Nozzle Fan: 0 RPM
        - Print Fan: 0 RPM
        - Fil Xd: 0 Yd:4

    - Int: 98 Shut: 3
- Belt status
    - X 268 (4/2/2018), 271 on 4/10
    - Y 281 (4/2 and 4/10)
- Temperatures
    - Nozzle: 27°
    - Bed: 23°
    - Ambient 29°
    - PINDA: 25°
- Voltages
    - PWR: 23.9V

Grey Feet Issue



After re-installing the grey rubber feet, the printer is sitting on the bundle of grey ribbon wires under the rail on the left side. Not good. The weight of the printer is not resting on the two feet on the left side. Rather, it is resting on the low-hanging ribbon cables on the left site. The issue is slight, but enough to "unweight" the two left-side feet.

As a first shot, I added fairly dense Styrofoam bars to the front and back of the printer for the rubber feet. The pic shows the left rear of the Mk3, with the ribbon cable hanging down below the plane of the four rubber feet.

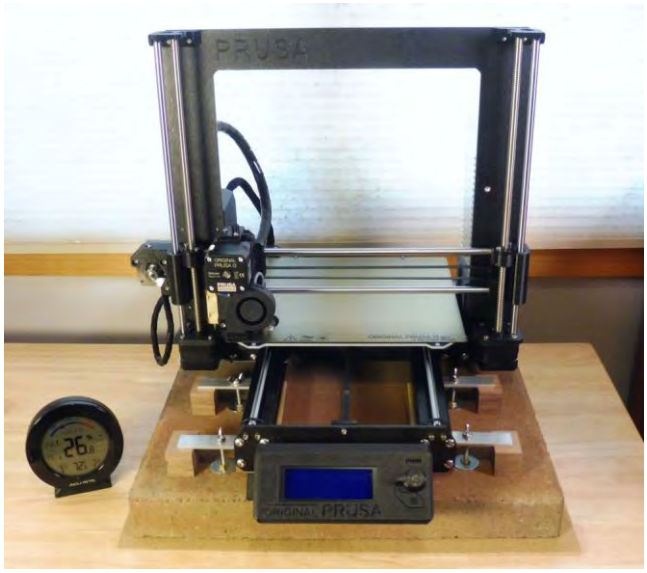
However, this issue led me down a long path of printer stabilization …

Rock Bottom Development

… documented on this post after two days of development (4/4–5/2018) on the Prusa forum: https://shop.prusa3d.com/forum/user-mods-octoprint-enclosures-nozzles--f65/rock-bottom-t15431.html

Here's my replacement for the i3 Mk3 rubber feet – spurred by suggestions and encouragement from folks who have dealt with vibration and vertical lines. I've basically bolted the printer's frame directly to a set of wood blocks and a 35 lb. Paver using six bracing bars.

I'll let the images do most of the explanation …



Here's the key info on parts and some construction notes (more pics below):

The "Rock" or "Paver" – a Home Depot Palomino 16″ × 16″ × 1.75″ Palomino Square Concrete Step Stone (Model # 72681, Internet #203647570, Store SKU #760441). It weighs 35.6 lbs. and more than double the weight of Mk3 (16.0 lbs. with the Spring Steel Sheet, but without the filament holder or filament).

Threaded rod – #8-32, hack-sawed to appropriate lengths.

"Riser blocks" from ½″ walnut (cut-offs I had lying around). Single-width blocks sit directly under the rails in six places. Double-width blocks are used under the outboard ends of the bracing bars.

"Bracing Bars" from ¾″ × ⅛″ flat aluminum bar, cut and drilled. These hold the Mk3 down onto the riser blocks.

Washers (1″) to hold the rod in place on the top and bottom of the Paver. Hex nuts for the top and bottom of the block, and wing nuts to facilitate removing the printer.

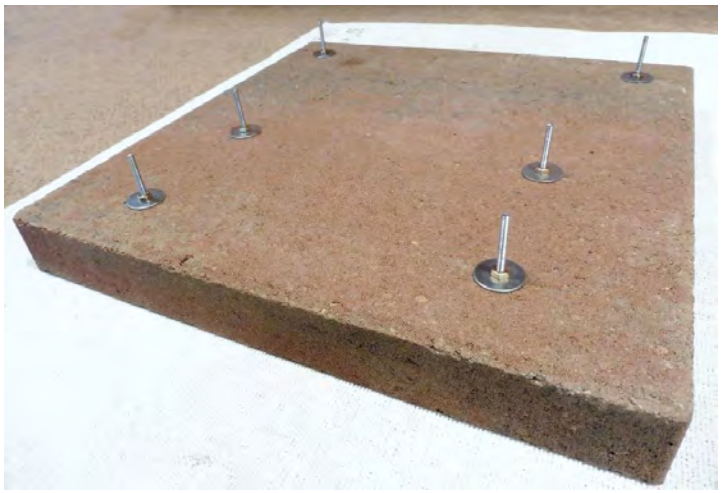
The bracing bars extend into the lower rails to pull down on the printer. Note that the position of the printer is not critical – there is a bit of play when assembling. The riser blocks are currently free-floating, but I plan on fixing them to the Paver with construction adhesive appropriate for a wood-concrete bond.

I drilled the holes with a 3⁄16″ carbide auger bit and a hammer drill. The countersinking was done with a 1″ Forstner bit – not designed for cement, but it did work, although it is probably toast. (I would opt for a 1¼″ Forstner in the future … centering the bit is difficult and the countersink tends to be off-center).

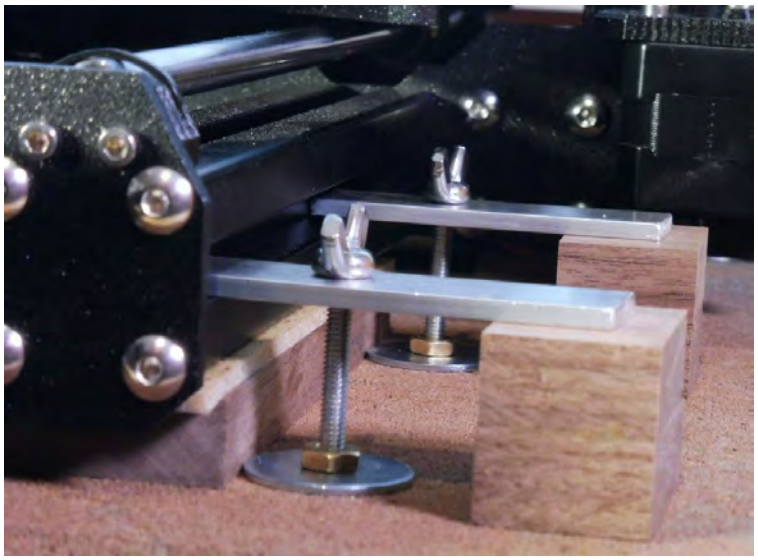
Finally, I've added an optional, thin cushion layer to the top of the riser blocks that sit under the printer rails – for noise abatement and to compensate for any out-of-true situation cause by the paver (which ***appears*** level). I have Eco Cork Foam – 0.126″ thick underlayment for engineered floors. (Home depot Model # 220000503, Internet #204700858, Store SKU #1001235985). This material is somewhat compressible … one concern is that the cork under some parts of the printer will compress more and the printer will not sit flat.

Countersinking on the bottom of the paver:

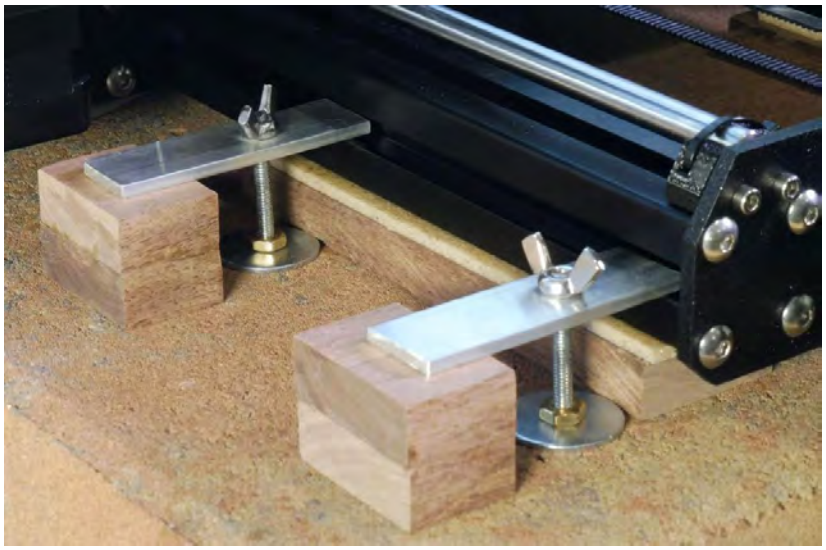
Top of the paver before riser blocks:



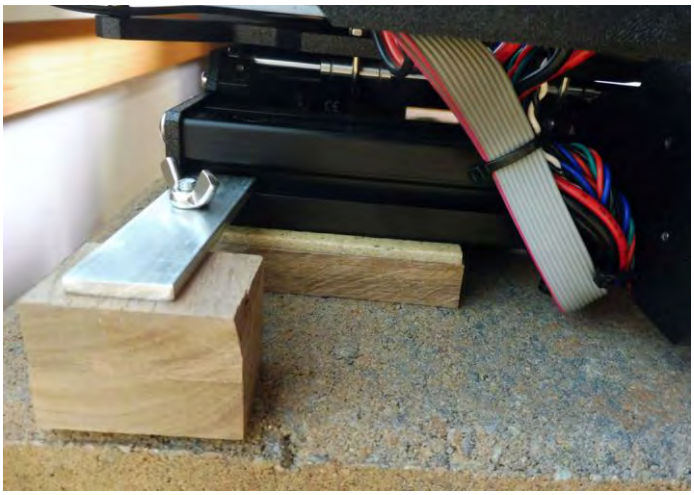
Assembled, right side, with printer rail, braces, and riser blocks with cushion.



Left side assembly:



Left rear assembly, showing low-hanging ribbon cables:



Re-Calibration

After the Rock Bottom development, this work was done on 4/5/2018 …

Self test done with NO Spring Steel Sheet. All OK.

Calib XYZ with no SSS, paper below the extruder

> *"XYZ calibration OK. X/Y axes are perpendicular. Congratulations!"*

Calibrate Z: Runs Z to the extreme top, then does a 9-point calibration. Completes

Support → XYZ Calibration details:

- Y dist from min
- Left: 10.65 (was 10.75 before Rock Bottom)
- Right: 10.84 (was 10.86 before Rock Bottom)
- Measured Skew: 0.03° (was 0.06° before Rock Bottom)

Mesh Bed Leveling "Calibration Done"

First Layer Calibration – Prints a calibration pattern followed by a 200um thick square. Based on examining that square, the setting for Live Z:

- –0.500mm: clearly too high (measured thickness 0.29 mm)
- –0.600mm: slightly better, but still too high (measured thickness 0.25 mm)
- –0.700mm: much better! May be the one (measured thickness 0.21 mm)
- –0.750mm: nice! (measured thickness 0.20 mm)
- –0.800mm: may be squished too much (measured thickness 0.20 mm)
- –0.850mm: too low / thin (measured thickness 0.28 mm!)
- –0.725mm: this is it! (measured thickness 0.20 mm)

Ghosting / Vibration Artifacts – Comparison Study

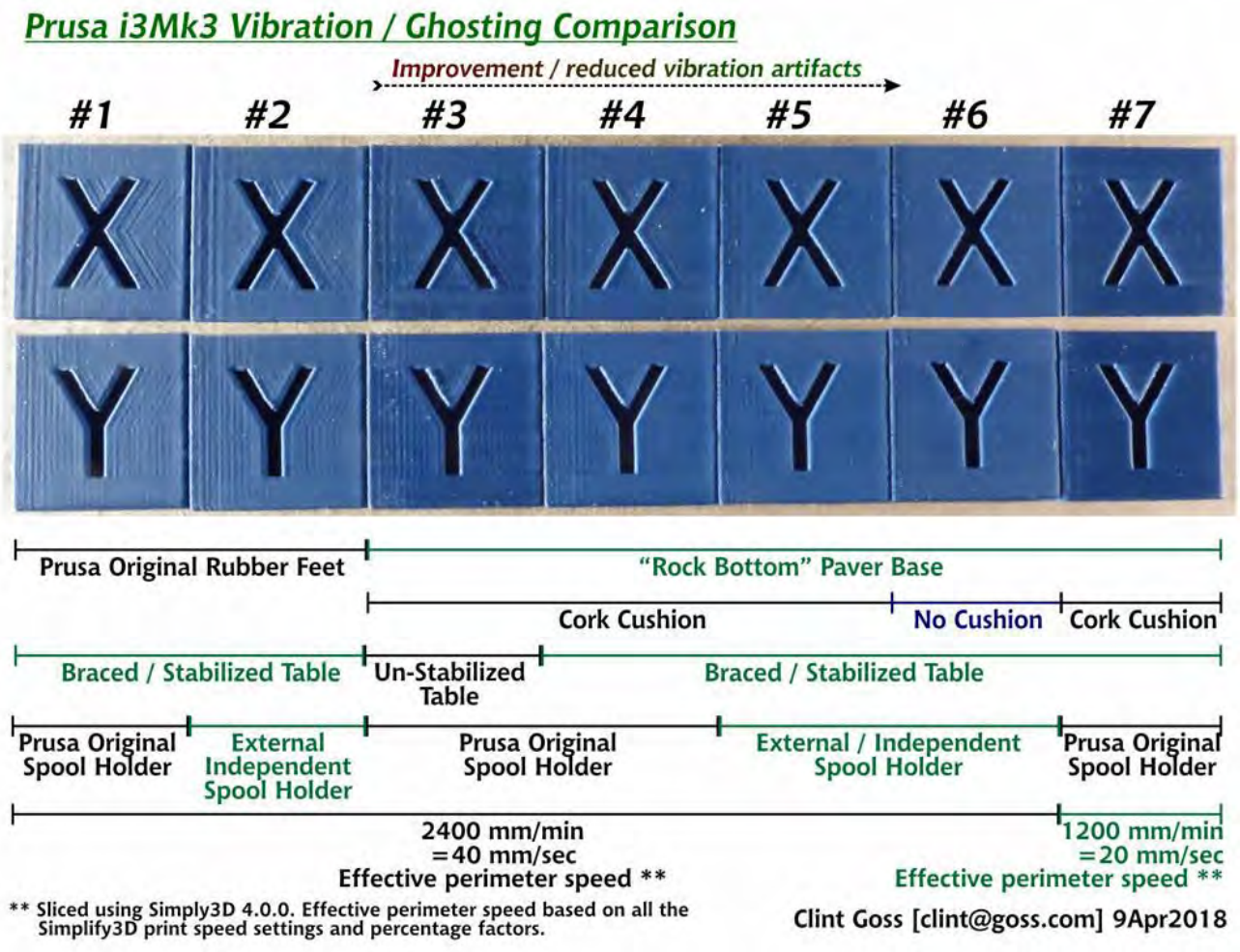
This work was done 4/7–9/2018 and this summary was posted to the Prusa Forum at https://shop.prusa3d.com/forum/general-discussion-announcements-and-releases-f61/ghosting-vibration-artifacts-t15529.html

Here's results of some testing I did over the last 3 days to identify issues causing ghosting / vibration artifacts.

For those who want an "executive summary", here are my results: If you want to reduce, I believe that you should, from most effective to least effective (but still worthwhile):

1. Print slower;
2. Replace Prusa's original rubber feet with a "Rock Bottom" style foundation;
3. Brace your table/bench to something as stable as your house (assuming lack of external vibrations such as truck traffic);
4. Consider an external spool holder,
5. (least effective) Remove any cushion layer in the "Rock Bottom" setup and go for a more rigid "direct connection".

For those who want the details …



I printed a set of 20mm XYZ Calibration Cubes (https://www.thingiverse.com/thing:1278865) under different setup conditions. The comparison shows the X and Y faces of the prints, ordered to show improvement from left to right (although this is not the order they were printed). Print conditions were kept as stable as I could, including the same G-code, except for #7 which changed only the perimeter speed. Print details are provided at the end of this description.

On the assumption that multiple issues potentially contribute to ghosting, I tried to think of all the things that might contribute and that I could do something about. I came up with these five questions / things to test:

> *How do Prusa's original rubber feet compare with my "Rock Bottom" Home Depot Paver modification?*

Compare tests #1 to #4 and #2 to #5. These two tests have the same conditions except for the rubber feet. There is a very noticeable reduction in artifacts.

> *Is the thin Cork cushion that I included in the "Rock Bottom" setup worse than a more rigid "No Cork" setup?*

Compare tests #5 to #6. There seems to be a slight, barely noticeable, possibly non-existent improvement. So slight that I've decided to use the cork cushion in my setup. I am concerned that a direct connection might wrench the frame rails out-of-true and the cork provides a compensation to this issue.

> *The table / workbench I am using originally had wheels, which caused quite a bit of shaking. I removed them as sat the workbench directly on a carpet over the foundation slab. However, you could still feel shaking in the table. Rather than removing the carpet, I braced the table against the walls of the house, using wood blocks. Is that an improvement?*

Compare tests #3 to #4. A noticeable improvement. There were many ways to couple the workbench to the house, but I had to come up with a reasonably aesthetic and non-damaging solution. I used blocks of very well-seasoned wood to brace the bench against the wall and between the wall and a very heavy cabinet.

The stock spool holder from Prusa noticeably wobbles during prints. Is placing the filament spool external to the printer an improvement for ghosting / vibration artifacts?

Compare tests #1 to #2 and #4 to #5. There seems to be a small improvement.

In addition to reducing artifacts, I'm also concerned about frame issues that might be caused in the long-run by *any* frame-mounted spool holder … so I think this mod is a good one.

What is the effect of print speed?

Compare tests #4 to #7 – the effect of a reduction to 50% print speed for perimeters is massive – I think the most significant contribution to reducing ghosting / vibration artifacts.

Details of prints #1 to #6. Print #7 was modified to reduce the speed

Clint Goss, 6Apr2018 to 8Apr2018, `xyzCalibration_cube.stl`, (thing:1278865, by iDig3Dprinting, 19Jan2016, CC-BY-SA)

Prusa i3Mk3 (SN CZPX1218X004XC53322, EINSY_04a, E3Dv6Full/0.4mm, 26Mar2018, FW 3.1.3-245)

S3D 4.0.0 Parameters (based on S3D-supplied Prusa i3Mk3 profile 23Mar2018):

Extruder: E-List [PrimExtr], Index Tool 0: Noz 0.40, ExtMult 1.00, ExtWid Man 0.40,
Ooze Control: YES Retr, RetrDist 1.00, ExRestart 0.00, RVertLift 0.00, RSpeed 2400,
Yes Coast, CoastDist 0.20, Yes Wipe, WipeDist 2.00

Layer: L-Extr [PrimExtr], LHt 0.10, TSolid 5, BSolid 4, Shells 2, Dir: InOut, No PISeq, No Vase,
FHt: 150%, FWid 100%, FSpeed 50% (2400 mm/min = 40 mm/sec), StartPoints: FastPrint

Additions: Yes Skirt, Sk-Extr PrimExtr, SkLayers 2, SkOffset 1.00, SkOutlines 2,
No Raft, No Pillar, No Ooze

Infill: I-Extr PrimExtr, IntPat Rect, ExtPat Rect, Infill 30%, OutOvr 20%, InWid 100%, MinLen 5.00,
Combine 1, No IncSolid, IntAng 45 / -45, No EvAngle, ExtAng 45 / -45

Support: No GenSupp

Temp: T-List [PrimExtr] T0, TType Extruder, No Layer, No Loop, Yes WaitStab, SetP 1:200°C,
T-List [HBed] T0, TType HBPlat, No Layer, No Loop, Yes WaitStab, SetP 1:60°C

Cooling: FanSpeed 1:0 / 2:100, No Blip, No Incr, No BrFan

G-Code: Yes 5D, No RelDist, Yes AllowZ, No Indep, No M101, Yes Sticky, No applyGOffsets,
GOffsets X:0.00 / Y:0.00 / Z:0.00, Yes UpMDef, MType Cart, Build X:250 / Y:210 / Z:210,
Orig X:0 / Y:0 / Z:0, Home X:Min / Y:Min / Z:Min, Flip No X, Yes Y, No Z,
THeadOffsets [Tool 0] X:0 / Y:0, Yes UpdFirm, FType RepRap, Baud 115200

Scripts: S3D Std Starting & Ending

Speeds: SpDefault 4800 mm/min (= 80 mm/sec), SpPerim 50%, SpSolidIn 80%, SpSupp 80%,
SpXY 12000 mm/min, SpZ 1000 mm/min, No AdjBelow, AdjBelowSec 15, AdjDown 20%

Other: Area 50, ExInflat 0.00, BrExMult 100%, BrSpMult 100%, No FixedAngle, No BrPerim, HComp 0.00, F-List [Tool 0] FilDiam 1.75, FilPrice 46, FilDen 1.25,
ChgRetDist 12, ChResDist -0.50, ChRetSp 600

Advanced: No Start, No Stop, ExThinType PerimOnly, InThinType GapFill, Overlap 25%. MinExLen 1.00, MinPWid 50%, MaxPWid 200%, EndExtDist 0.20, Yes Open, Yes ForceRet, No MinTRetr 3.00, Yes RetWipe, Yes WipeOuter, No AvoidCross, MaxDetour 3.0, NonManSeg Heal, No Merge.

MatterHackers Blue PRO Series PLA 1.75mm; 200°C / 60°C; Z=-0.725mm.

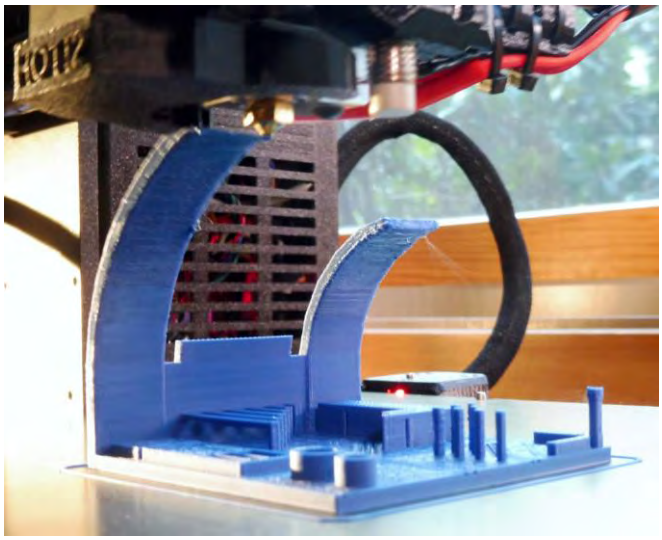
Early Test Prints

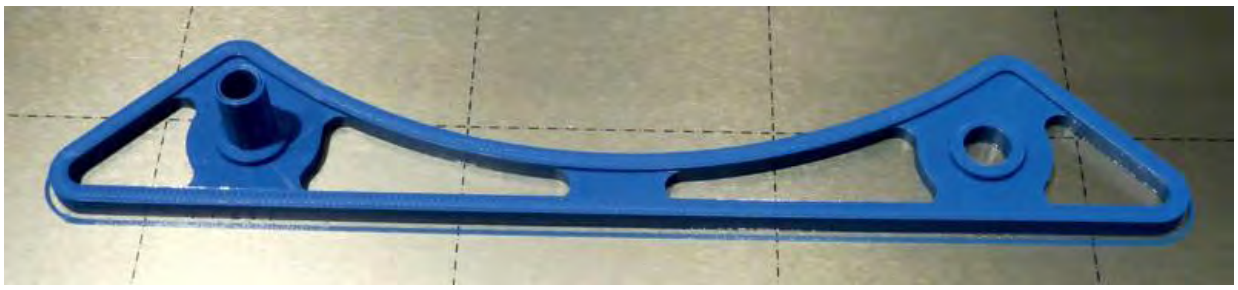
During 4/10-15/2018 a set of test prints were done, as well as quite a few prints developing the Split Flute trinket I designed. These were largely successful, although the Split Flute did have issues with warping when using Rigid.Ink PLA (but it was OK on MatterHackers Pro PLA). Settings for profiles have been saved in `.FFF` files.

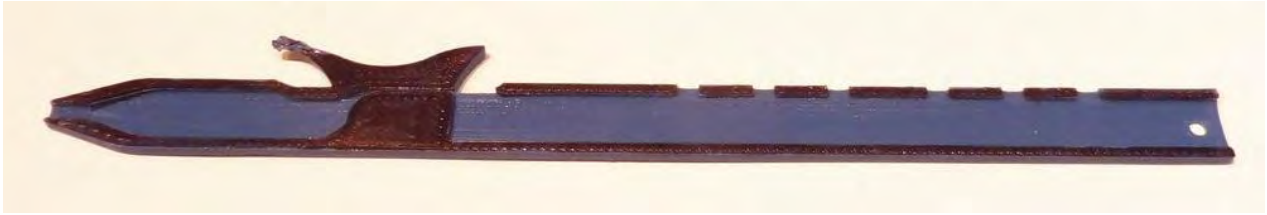
These models included:

- The All-in-One Test Mini "torture test"
- The Rotation Visualizer, CA-glued to 8×3 mm (0.32″ × 0.12″) Rare Earth magnets from EBay, installed on the printer
- 3D Benchy (a classic!)
- Spool holders for getting the printer spool off the frame of the printer
- Shelf Feet for leveling the Uline shelving
- Various filament clips. They printed well, but none of them actually work!
- The Tree Frog at 150µm (4/17/2018).

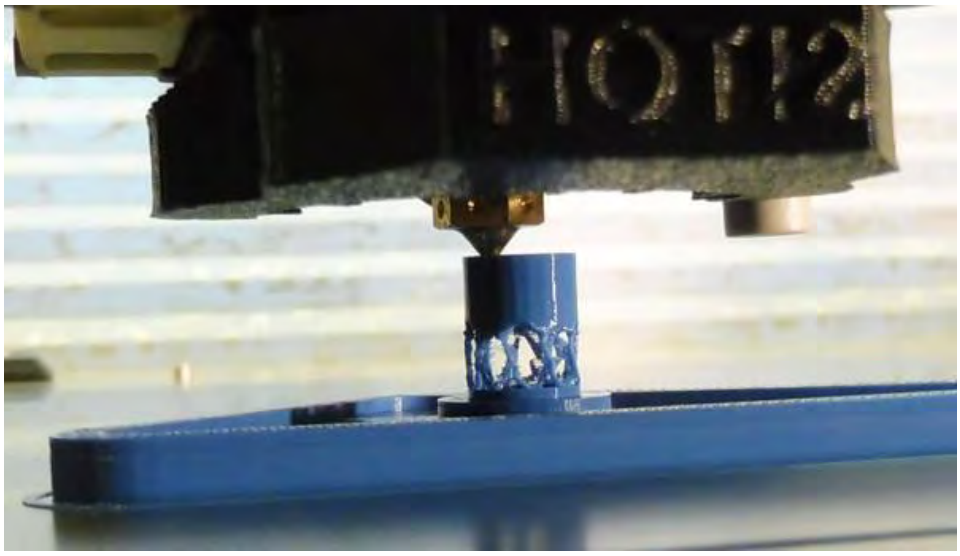
Here are some pics:







Bulge Jam



While printing the Filament Spool components, I encountered this problem 4 times in a row on the thin vertical element of the print. Symptoms included severe under-extrusion and a loud "clicking" sound from the extruder. The filament was almost completely jammed, and the gears were slipping on the filament.

The jams were cleared each time with the acupuncture needle that came with Pi3Mk3 and opening the gear compartment and cutting out the bulging filament.

This post on the Prusa forum on 4/15/2018 explains my findings on this issue:

https://shop.prusa3d.com/forum/others-archive--f66/clicking-printhead-filament-stuck--t14916-s40.html#p77927

I also hit this speed bump, but think I solved it. Don't know if the cause of your speed bump is the same thing that caused my speed bump, but I suspect it is.

Bottom line: I was printing very slowly. The filament softened further up the PFTE tube than usual and, on a retraction, that soft material was above the tube. On the next forward extrusion, the filament fattened enough to prevent passage back down the tube. I'll dub this a ***"Bulge Jam"***.

How I got to this slow print mode was a combination of the CSG model design ("Simple Smooth Spool Holder ! Updated !" by John Pfeiffer - https://www.thingiverse.com/thing:989957) and the cascading slowdown parameters of Simplify3D 4.0.1 (S3D).

The model design has a tall, hollow tube that slices as 2 perimeters with no infill. The speed of printing this hollow tube seems to be controlled by the S3D parameters:

A. Speeds → Default Printing Speed (speed)
B. Speeds → Outline Underspeed (percentage)
C. Speeds → Speed Overrides → Adjust Printing Speed (checkbox)
D. Speeds → Speed Overrides → ... for layers below (time)
E. Speeds → Speed Overrides → Allow speed reductions down to (percentage)

If C (Adjust Printing Speed) is checked, then the actual printing speed for the hollow tube (which takes longer to print than D) is A × B × E.

S3D scales the Default Printing Speed by both the Outline Underspeed and the Allow Speed Reductions Down To settings.

The default settings in the Prusa i3 Mk3 profile currently provided by Simplify are (A) 4,800 mm/min (80 mm/sec), (B) 50%, and (E])20%. I lowered the default print speed for better rendition of the lower part of the model to 2,400 mm/min, so A × B × E worked out to 240 mm/min or 4 mm/sec. This triggered the Bulge Jam.

Changing E (Allow speed reductions down to) from 20% to 40% cured the issue.

Personally, I think that users of S3D would benefit from a GUI that allowed (provided the option of) setting of speeds directly, rather than in percentages ... but that's another issue. We wind up back-figuring the speeds by trial and error, rather than by having direct control.

WorkSpace Setup

Developed the workspace area with some improvements:

- Lighting – rope, spot lights, gooseneck near the printer.
- Temp and Humidity sensor
- Uline shelving
- Boards cut from Luan and installed on the shelves. Initially cut by Torno Lumber. Corners cut with a 1″ hole saw.
- Bullseye level (Amazon: Bubble Spirit Level, 66x10mm Circular Bullseye Level Inclinometers, Fluorescent Yellow)

- A hole cut in the shelves to guide the filament.

Still TBD:

- Smoke / CO_2 sensor / alarm. *DONE – wired to the shelf above the printer 4/26/2018.*
- Exhaust Fan (have the hardware!)

Ethanol Degradation Testing

On 4/16/2018 I began a test of how Ethanol (Grain Alcohol) affects PLA prints. This is important since we intend to sanitize loaner Breath Flutes in 70% alcohol.

See the `/Testing/EthanolDegradationTesting_April2018` directory for details.

S3D Settings and Core Profiles Research

During the period 4/19–24/2018, I undertook a major effort to:

- collect all the documentation available for the S3D parameters and settings and
- assemble all the "core" S3D profiles for the Pi3Mk3.

This resulted in two separate documents, both published on the S3D and Prusa forums on 4/24/3018:

- `S3D_SettingsCG.pdf`, in `/S3D_Profiles/Simplify3D_Settings_Documentation`, located at http://www.BreathFlute.com/pdf/S3D_SettingsCG.pdf, and
- `S3D_ProfilesCG.pdf`, in `/S3D_Profiles/Simplify3D_Profiles_Comparison`, located at http://www.BreathFlute.com/pdf/S3D_ProfilesCG.pdf.

Also, at this point, I'm changing the way I document profiles. This more compact format allows ***all*** the S3D profile parameters to be easily and completely recorded.

https://shop.prusa3d.com/forum/general-discussion-announcements-and-releases-f61/simplify3d-settings-and-profiles-t15905.html

Simplify3D Settings and Profiles

Tue Apr 24, 2018 11:43 am

I've cooked up two documents that may be useful for MK3 owners who use Simplify3D:

A collection of documentation on **S3D Parameters and Settings** from various sources (76 pages / 2.8 MB):

http://www.BreathFlute.com/pdf/S3D_SettingsCG.pdf

... and a detailed **Comparison of twelve MK3 S3D profiles** from various sources (including S3D and Jo Průša) (21 pages / 0.3 MB):

http://www.BreathFlute.com/pdf/S3D_ProfilesCG.pdf

These are my working documents to try to get a handle on the myriad options that S3D offers ... and to get away from the cycle of

```
while (1) {
    "Let's try this / that";
    Print for C * G * sqr(Z) + 0.017 hours;
    "Hm … that did something … but not exactly what I expected / hoped /
yearned for …"
}
```

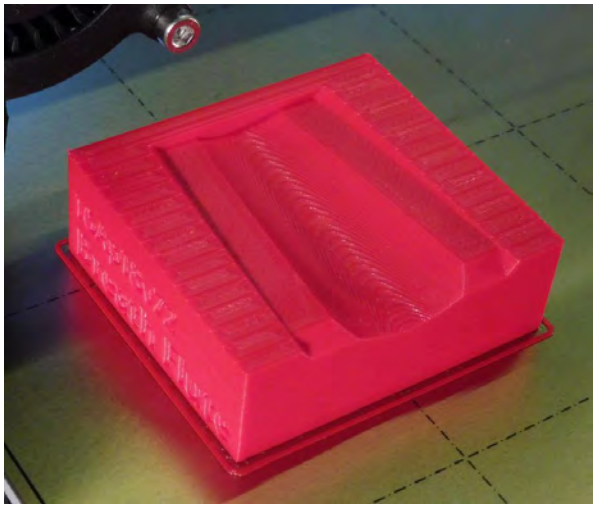
I hope this is useful! … feedback always welcome …

-- Clint Goss

Breath Flute v72

Did significant updates to the OpenSCAD model for the Breath flute, and finalized v72 on 4/17/2018 in the AM. The updates are listed above (many pages back) in the section titled ***Breath Flute #72 – Improvements Beginning 12/1/2017***.

4/16/2018 Print of SandR in Rigid.Ink Red PLA on Pi3Mk3

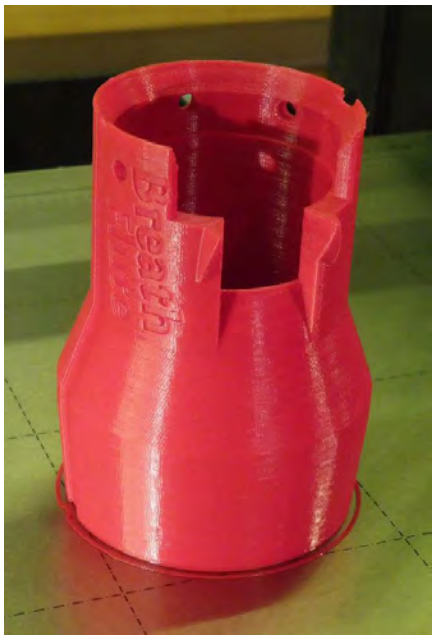


Did not record the specifics of this print … However, it appears (on 5/7/2018) that the print was:

- Printed: April 16, 2018
- Source: `BFlute_072.scad`
- STL: `BFlute_072_CG125pF3_SR_20180416_0620.stl` (1.5 MB)
- Factory: `SR_20180416.factory`
- Profile: `BF Tool Pi3Mk3 20180416.fff`
- Based on: ??
- G-code: `BFlute_072_CG125pF3_SR_20180416_0620.gcode` (4.4 MB)
- Slicer: Simplify3D 4.0.1. Unknown modifications:
- Printer: Pi3Mk3/CG, 0.40mm brass E3D nozzle
- Filament: Rigid.Ink Red PLA 1.75mm Filament. Specs:

Results: Very good!

4/17/2018 Print of BodyDist in Rigid.Ink Red PLA on Pi3Mk3



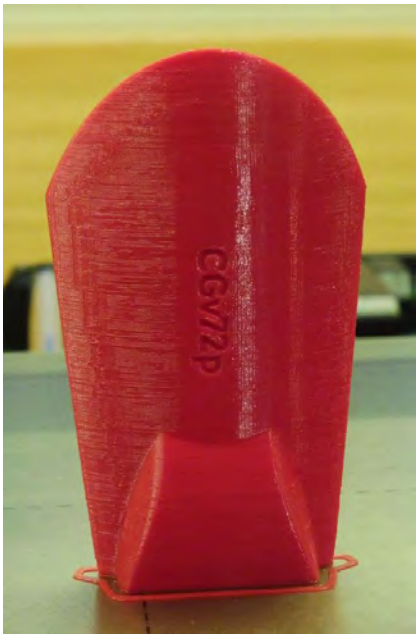
The first print of v72 is the `BodyDist` component, using Red PLA, **100µm layers, 100% infill @ 2400 mm/min**.

- Printed: April 17, 2018
- Source: `BFlute_072.scad`
- STL: `BFlute_072_CG125pF3_BD_20180417_0506.stl` (6.8 MB)
- Factory: `BFlute_072_20180417_CG125pF3_BD_20180417_0506.factory`
- Profile: `S3D_20180417_BodyDist.fff`
- Based on: `Pi3Mk3 Pristine S3D 20180412.fff / PLA / High` (see `S3D_SettingsCG.pdf`)
- G-code: `BFlute_072_20180417_CG125pF3_BD_20180417_0506.gcode` (25.3 MB)
- Slicer: Simplify3D 4.0.1. Profile modifications:
  - Layer: LHt 0.10, Shells 3
  - Additions: SkLayers 1, SkOffset 1.00
  - Infill: Infill 100%

    - Temp: T-List [PrimExtr] SetP 1:200°C, T-List [HBed] SetP 1:60°C
    - Cooling: FanSpeed 1:0 / 2:50
    - Speeds: SpDefault 2400 mm/min (= 40 mm/sec), SpPerim 50% (1200 mm/min = 20 mm/sec), SpSolidIn 80% (1920 mm/min = 32 mm/sec), SpSupp 80% (1920 mm/min = 32 mm/sec), AdjDown 40% (SpDefault: 460 mm/min = 16 mm/sec, SpPerim: 480 mm/min = 8 mm/sec)
- Printer: Pi3Mk3/CG, 0.40mm brass E3D nozzle
- Filament: Rigid.Ink Red PLA 1.75mm Filament. Specs:
    - Recommended Extrusion Temperatures: 180°C
    - Recommended Bed Temperature: max 45°C
- Predic build time: 8h 57m; Filament length: 16.204 m, Plastic weight: 48.72g (0.11 lb)

Results: Very good! Some ringing, overhang on 45° inside bevel is rough, and the sharp tip at the top is imperfect.

4/18/2018 Print of Bird in Rigid.Ink Red PLA on Pi3Mk3



Print of the `Bird` component with the same profile as the `BodyDist` component, using Rigid.Ink Red PLA, **100µm layers, 100% infill @ 2400 mm/min**.

- Printed: April 18, 2018
- Source: `BFlute_072.scad`
- STL: `BFlute_072_CG125pF3_BI_20180417_0506.stl` (982 KB)
- Factory: `BFlute_072_20180418_CG125pF3_BI_20180417_0506.factory`
- Profile: `S3D_20180417_BodyDist.fff` (see above)
- Based on: *(profile was not unmodified)*
- G-code: `BFlute_072_20180418_CG125pF3_BI_20180417_0506.gcode` (3.9 MB)
- Slicer: Simplify3D 4.0.1
- Printer: Pi3Mk3/CG, 0.40mm brass E3D nozzle
- Filament: Rigid.Ink Red PLA 1.75mm Filament.
- Predic build time: 2h 3m, Filament length: 2.015 m, Plastic weight: 6.06g (0.01 lb)

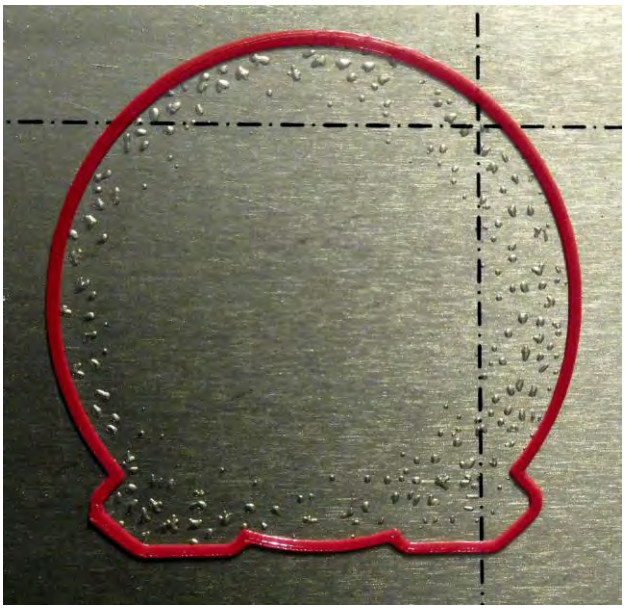
Results: Nice!

4/19/2018 Print of BodyProx in Rigid.Ink Red PLA on Pi3Mk3

Print of the `BodyProx` component with the same profile as the `BodyDist` component, using Rigid.Ink Red PLA, **100µm layers, 100% infill @ 2400 mm/min.**

- **Printed:** April 19, 2018
- **Source:** `BFlute_072.scad`
- **STL:** `BFlute_072_CG125pF3_BP_20180417_0506.stl` (30.2 MB)
- **Factory:** `BFlute_072_20180419_CG125pF3_BP_20180417_0506.factory`
- **Profile:** `S3D_20180417_BodyDist.fff` (see above)
- **Based on:** *(profile was not unmodified)*
- **G-code:** `BFlute_072_20180419_CG125pF3_BP_20180417_0506.gcode` (24.9 MB)
- **Slicer:** Simplify3D 4.0.1
- **Printer:** Pi3Mk3/CG, 0.40mm brass E3D nozzle
- **Filament:** Rigid.Ink Red PLA 1.75m
- **Predic build time:** 9h 3m, Filament length: 16.775 m, Plastic weight: 50.44g (0.11 lb)
- **Actual build time:** 10h 13m.

Results: It worked! Noticable grit from the overhang at the proximal end of the flue opening – the "Crown" of the `BodyProx` component. Also … here's a pic of the ramp of this print, as well as a pic of the bubbles in the PEI surface I used on a post on the Prusa forum:



4/20/2018 Print of HeatbedBracket_DomAroneseno_Pi3Mk3_longer in Rigid.Ink Red PLA

Print of Dom Aroneseno's bracket for the Mk3 heatbed using Rigid.Ink Red PLA, 100µm layers, 30% Full Honeycomb infill @ 4800 mm/min. This is a test part for sizing … the "real" part needs to be in ABS to avoid melting below the heatbed.

- Printed: April 20, 2018
- Source: https://www.thingiverse.com/thing:2790787
- STL: `HeatbedBracket_DomAroneseno_Pi3Mk3_longer.stl` (43 KB)
- Factory: `HeatbedBracket_DomAroneseno_Pi3Mk3_longer_20180420a.factory`
- Profile: `HeatbedBracket_DomAroneseno_20180420.fff`
- Based on: `Pi3Mk3 Pristine S3D 20180412.fff / PLA / Medium` (see `S3D_SettingsCG.pdf`)
- G-code: `HeatbedBracket_DomAroneseno_Pi3Mk3_longer_20180420a.gcode` (1.0 MB)
- Slicer: Simplify3D 4.0.1. Profile modifications:
  - Layer: LHt 0.20, FWid 105%,
  - Additions: SkOffset 1.00
  - Infill: Infill 30%, IntPat FullH
  - Temp: T-List [PrimExtr] SetP 1:200°C, T-List [HBed] SetP 1:60°C
  - Cooling: FanSpeed 1:0 / 2:50
- Printer: Pi3Mk3/CG, 0.40mm brass E3D nozzle
- Filament: Rigid.Ink Red PLA 1.75m
- Predic build time: 0h 24m, Filament length: 2.921 m, Plastic weight: 8.78g (0.02 lb)
- Actual build time: 0h 51m
- Printed part marked: "#1"

Results: Very good! Used this part in a test … but only ran the heatbed up to 32°C, so the part came unstuck. Camera appeared to vibrate, but the time-lapse was OK.

Need to make it thicker, more rigid, longer fork arm, tighter fit, slotted bolt-hole, rounded entry to the fork slot.

4/20/2018 Print of XYZ20mmCalibrationCube to test the GoPro and Bracket

Print of XYZ20mmCalibrationCube using Rigid.Ink Red PLA, 100µm layers, 30% infill @ 2400 mm/min, at a low heatbed temp of 32°C (set live), with the GoPro mounted to record it all!

- Printed: April 20, 2018
- Source: https://www.thingiverse.com/thing:2790787
- STL: `xyzCalibration_cube.stl` (7 KB)
- Factory: `XYZ20Cube_20180408_S3D_Pi3Mk3_RiPLA_100um_30pct_2400.factory`
- Profile: `XYZCalCube CG Pi3Mk3 RiPLA 100um 2400 30% 20180408.fff`
- Based on: `Prusa i3 Mk3 S3D Pristine 20180323.fff / PLA / High` (see above)
- G-code: `XYZ20Cube_20180408_S3D_Pi3Mk3_RiPLA_100um_30pct_2400.gcode` (560 KB)
- Slicer: Simplify3D 4.0.1. Profile modifications:
  - Layer: LHt 0.10
  - Additions: SkOffset 1.00

    - Infill: Infill 30%
    - Temp: T-List [PrimExtr] SetP 1:200°C, T-List [HBed] SetP 1:60°C
    - Speeds: SpDefault 2400 mm/min (= 40 mm/sec), SpPerim 50% (1200 mm/min = 20 mm/sec), SpSolidIn 80% (1920 mm/min = 32 mm/sec), SpSupp 80% (1920 mm/min = 32 mm/sec), AdjDown 40% (SpDefault: 460 mm/min = 16 mm/sec, SpPerim: 480 mm/min = 8 mm/sec), No AdjBelow, AdjBelowSec 15
- Printer: Pi3Mk3/CG, 0.40mm brass E3D nozzle
- Filament: Rigid.Ink Red PLA 1.75m
- VidSetup: GoPro5 Black, Time-Lapse video, Res 1080, Intervals 10s, Zoom LINR (Linear)
- Video: `XYZ20Cube_20180408_S3D_Pi3Mk3_RiPLA_100um_30pct_2400_GOPR0002.mp4`
- Live Tuning:
    - Reduce bed temperature from 60°C to 32°C

GoPro 5 Black Setup, mounted on the right front corner of the build plate:

- Time Lapse Video
- 1080 resolution
- 10s intervals
- Linear (LINR) zoom factor

Results: Disastrous! Print became unstuck and printed for a while in the air. Had to be cleaned up with a brass wire brush.

Realizations:

- You cannot print at 32°C and have a PLA part reliably stick.
- The GoPro vibrates. It needs to be stabilized. This probably means designing my own version of the HeatbedBracket.
- The vertical angle of the GoPro needs to be adjustable … it is too high for this printer, but should be made adjustable in any case.

4/25/2018 Print of HeatbedBracket_v101 in Rigid.Ink Red PLA

Redesign of the bracket from scratch in OpenSCADPrint of the CG HeatbedBracket v1.01 using Rigid.Ink Red PLA, 100µm layers, 30% Full Honeycomb infill @ 4800 mm/min. This is a test part for sizing … the "real" part needs to be in ABS to avoid melting below the heatbed.

- Printed: April 25, 2018
- Source: `HeatbedBracket_v101.scad`
- STL: `HeatbedBracket_v101.stl` (380 KB)
- Factory: `HeatbedBracket_v101.factory`
- Profile: `HeatbedBracket_CG_20180425a.fff`
- Based on: `Pi3Mk3 Pristine S3D 20180412.fff / PLA / Medium` (see `S3D_SettingsCG.pdf`)

- G-code: `HeatbedBracket_v101.gcode` (2.7 MB)
- Slicer: Simplify3D 4.0.1. Profile modifications (same as `HeatbedBracket_DomAroneseno_20180420`):
  - Layer: LHt 0.20, FWid 105%,
  - Additions: SkOffset 1.00
  - Infill: Infill 30%, IntPat FullH
  - Temp: T-List [PrimExtr] SetP 1:200°C, T-List [HBed] SetP 1:60°C
  - Cooling: FanSpeed 1:0 / 2:50
- Printer: Pi3Mk3/CG, 0.40mm brass E3D nozzle
- Filament: Rigid.Ink Red PLA 1.75m
- Predic build time: 0h 54m, Fil. length: 6.770 m, Plastic weight: 20.36g (0.024 lb), Cost 0.94
- Actual build time: 1h 32m
- Printed part marked: "#2"

Results: Bracket did not fit! See the OpenSCAD code for measurements. Heatbed clearance was too small.

Modified for next print …

4/25/2018 Print of HeatbedBracket_CG_v102_Right in Rigid.Ink Red PLA

Updated design v1.02 using Rigid.Ink Red PLA, 100µm layers, 30% Full Honeycomb infill @ 4800 mm/min.

- Printed: April 25, 2018
- Source: `HeatbedBracket_CG_v102.scad`
- STL: `HeatbedBracket_CG_v102_Right.stl` (43 KB)
- Factory: `HeatbedBracket_CG_v102_Right.factory`
- Profile: `HeatbedBracket_CG_20180425b.fff`
- Based on: `HeatbedBracket_CG_20180425a.fff`
- G-code: `HeatbedBracket_CG_v102_Right.gcode` (3.2 MB)
- Slicer: Simplify3D 4.0.1. Profile modifications:
  - Layer: FSpeed 30%
  - Infill: Infill 40%, Yes IncSolid 10

Speeds: SpXY 4800 mm/min (= 80 mm/sec), SpZ 600 mm/min (= 10 mm/sec)

- Printer: Pi3Mk3/CG, 0.40mm brass E3D nozzle
- Filament: Rigid.Ink Red PLA 1.75m
- Predic build time: 1h 05m, Fil. length: 7.891 m, Plastic weight: 23.73g (0.05 lb), Cost 1.09
  Note that the predicted time of 1h 05m did not change when reducing the X/Y Move from 12000 mm/min to 4800 mm/min and Z Move down from 1000 mm/min to 600 mm/min.
- Actual build time: 1h 52m
- Printed part marked: "#3"

Results: Excellent! Fit's great. Appears stiffer than the Dom Aroneseno version. Ready for MakeXYZ production in ABS!

4/25/2018 Upload of HeatbedBracket_CG_v102_Right to MakeXYZ.com

Updated design v1.02 using Rigid.Ink Red PLA, 100µm layers, 30% Full Honeycomb infill @ 4800 mm/min.

- Uploaded: April 25, 2018
- Source: `HeatbedBracket_CG_v102.scad`
- STL: `HeatbedBracket_CG_v102_Right.stl` (364 KB)

Had trouble figuring out how to place an order, because of the size of the model. Sent them an email. Then finally ignored the settings and placed the order with parameters FDM, ABS, Black, 30% infill, 0.2mm layers.

4/25/2018 Measurement of Guitar Strings

Measured the SunSunRise Professional 6 Steel 150XL Strings for Acoustic Guitar purchased from Amazon on 11/30/2017 (https://www.amazon.com/gp/product/B01JPDA110/). These are useful for cleaning nozzles. Measured just the solid core of each string – the lowest 4 strings are wound, but the outside of those wound strings was not measured:

- 1st string / plain: 0.25 mm (0.10 in)
- 2nd string / plain: 0.33 mm (0.13 in)
- 3rd string / wound: 0.30 mm (0.12 in)
- 4th string / wound: 0.38 mm (0.15 in)
- 5th string / wound: 0.38 mm (0.15 in)
- 6th string / wound: 0.44 mm (0.17 in)

4/25/2018 EndExtDist Change Needed

- Advanced: Need to change EndExtDist fom 0.20 to 0.40mm, based on advice from Naver as shown in the `S3D_ProfilesCG.pdf` document.

Breath Flute #73 – Improvements Beginning 5/1/2018

The issues addressed are …

- (from v72) Simplify the Shrinkage factor implementation. It is unreasonable to provide a range of different sizes for general use. People who are printing directly from STL can set a various scaling factors in their slicer! Set all shrinkage factors to ?zero? Should we keep the one-letter `varMaterial` tag in the name?? Should we still print the material on the flute body and bird (the "p")?? ***TBD***
- (from v72) Create a new Inset Splicer tool (`InSplice`) to precisely cut the angles for insets on the sides of the flute body. This could be done as an external model, rather than in the every-ballooning `BFlute.scad` file. ***TBD***
- Mount for the GoPro camera, to record time-lapse images. ***TBD***
- Fire / Smoke Detector / Alarm installation… *DONE – wired to the shelf above the printer 4/26/2018.*
- Two holes in the back of the `BodyProx` component, providing ports into the enclosed space below the ramp. This is to allow liquid (alcohol) to flow freely into this area, preventing the component from floating when it is being sanitized. *DONE – 5/1/2018.*
- Make the solid portion at the distal end of the `BodyProx` component smaller – all that material is not needed. *DONE – 5/1/2018 with an internal cone.*
- Consider slicer changes based on strength research done for the `S3D_SettingsCG.pdf` document:
  - All settings updated for the `HeatbedBracket_CG` project. *DONE – 5/2/2018.*
  - The EndExtDist change noted on 4/25/2018 above. *DONE – 5/2/2018.*
  - Orientation of the Infill angles to maximize strength for bending loads in the Y axis – the most likely loads for the Breath Flute. This is probably something like 0 / +50 / -25 / +25 / -50. *DONE – 5/2/2018.*
- A potential issue involves the distal face of the `Bird` component. The `Bird` cannot be printed with a brim, because the brim masks the (fairly subtle) chamfer on the bottom of the distal end of the `Bird`. The brim is also difficult to remove. However, with the distal face of the `Bird` perpendicular to the longitudinal axis of the flute, the `Bird` component is actually canted and somewhat top-heavy. This could spell disaster, if the (rather small) distal face of the `Bird` is not stuck tightly to the print bed. One solution would be to cant the distal face of the `Bird` (slightly) to allow the component to print more vertically. However, that face angle is a design parameter (although it is currently defaulting to a generic 90°), and this solution would fix that parameter at a certain value. ***TBD***
- Counteract the bit of "elephant's foot" (squishing out at the bottom layer) of the `BodyProx` component, by creating a slight, short bevel for a layer or two. The Elephant's Foot is stopping the `BodyProx` from inserting into the `BodyDist` component. We currently have to file off the bottom of the `BodyProx` component. Don't do too much, or there will be a gap at the mortice step in the `BodyDist` component that should line up with the base of `BodyProx`. *DONE – 5/1/2018.*
- Create a new `Foot` component for testing the size of the connection to the body tube … just the bottom-most portion of the body. *DONE – 5/4/2018.*

Breath Flute-Specific Pi3Mk3 Profile for PLA with a 0.40mm Nozzle at LHt 0.10mm

On 5/2/2018, I began work on an S3D profile that is specifically for use with prints of the Breath Flute. It is based on the core profile `Pi3Mk3 Pristine S3D 20180412.fff / PLA / High`. The new workflow for this "working" profile will be to make modification directly to the profile and save them (i.e. to the registry). Then, on each print, export the `.fff` file with the print.

Here are all the parameters of that profile, with differences from the core profile shown in red.

Profile: `Pi3Mk3_BF_CG.fff / PLA / High`

Extruder: E-List [PrimExtr], Index Tool 0: Noz 0.40, ExtMult 1.00, ExtWid Man 0.40,
Ooze Control: YES Retr, RetrDist 1.00, ExRestart 0.00, RVertLift 0.00,
RSpeed 2400 mm/min (= 40 mm/sec),
Yes Coast, CoastDist 0.20, Yes Wipe, WipeDist 2.00

Layer: L-Extr: PrimExtr,
// Layer Height 0.1mm = 100um – good for visual quality. However, Infill=>Combine set to 2
// to print infill at 0.2mm, which has 24% better Yield Stress, [3DMATTER 2015]
LHt 0.10,
TSolid 4, BSolid 4,
Shells 3, *// Highest Yield Stress, based on the [3DMATTER 2015] study*
Dir: InOut, No PISeq, No Vase,
FHt: 150%, *// S3D Default … works well for me. Jo Prusa & Jeff Golden use 200%*
FWid 105%, *// A little extra extrusion to aid in sticking to the bed. Chris Warkocki uses 102%*
FSpeed 35% (@SpDefault of 4800 mm/min → 1680 mm/min = 28 mm/sec), *// Warkocki uses 25 mm/sec, other experienced use 30 mm/sec*
// Start on the back. For the Bird component, the seam will be in critical areas (roof of the flue,
// top curved bevel edge), but those areas require sanding in any case.
// Issue: As we move the print around on the bed to handle PEI bubbles … this needs to be adjusted!
StartPts: Choose, X:125.0 / Y:210.0 *// Back of model!*

Additions: Yes Skirt, Sk-Extr PrimExtr, SkLayers 1, SkOffset 3.00, SkOutlines 2,
No Raft, R-Extr PrimExtr, Top 3, Base 2, ROffset 3.00, SepDist 0.14, TopInfill 100%,
SpAbRaft 30% (@SpDefault of 4800 mm/min → 1440 mm/min = 24 mm/sec),
No Pillar, P-Extr AllExtr, PPWidth 12.00, PPLoc North-West,
PPSpMult 100% (@SpDefault of 4800 mm/min → 4800 mm/min = 80 mm/sec),
No Ooze O-Extr AllExtr, OOffset 2.00, OPerims 1, OShape Waterfall, OAngle 30°,
OSpMult 100% (@SpDefault of 4800 mm/min → 4800 mm/min = 80 mm/sec)

Infill: I-Extr PrimExtr,
IntPat Rect, *// Rectilinear for greatest Max Stress, based on the [3DMATTER 2015] study*
ExtPat Conc, *// Concentric, so that visible surfaces show arcs rather than lines*
Infill 90%, *// Infill for greatest Yield Stress, based on the [3DMATTER 2015] study*
OutOvr 25%, *// S3D is 20%, KeyboardWarrior 30%, Jo Prusa 25%*
InWid 100%,
MinLen 2.00, *// S3D is 5, Jo Prusa is 2, Chris Warkocki is 1.00*
Combine 2, *// Force infill to print at 0.2mm, which increases Yield Stress by 24% [3DMATTER 2015]*
No IncSolid, DiaphEvery 20,
IntAng: 0 / +50 / -25 / +25 / -50 / 90, *// Best Max Stress along longitudinal axis, [3DMATTER 2015]*
No EvAngle,
ExtAng: 45 / -45 *// This should not have any effect on slicing, since ExtPat is Concentric*

Support: No GenSupp, Sp-Extr PrimExtr, SuppInfill 40%, ExInflDist 0.00, BaseLayers 0, CombEvery 1,
DenseSupp D-Extr PrimExtr, DenseLayers 0, DenseInfill 70%,
APType Normal, APRes 4.00, APAngle 45°, HSep 0.30, UpLay 1, LowLay 1, SupAng 0

Temp: T-List [PrimExtr] T0, TType Extruder, No Layer, No Loop, Yes WaitStab,
SetP 1:210°C / 2:205°C, *// Somewhat arbitrary setting for PLA*
T-List [HBed] T0, TType HBPlat, No Layer, No Loop, Yes WaitStab,
SetP 1:65°C / 2:55°C *// Somewhat arbitrary setting for PLA*

Cooling: FanSpeed 1:0 / 2:100,
No Blip, No Incr, ITime 45sec, MxFSp 100%, No BrFan, BrSpOvr 100%

G-Code: Yes 5D, No RelDist, Yes AllowZ, No Indep, No M101, Yes Sticky, No applyGOffsets,
GOffsets X:0.00 / Y:0.00 / Z:0.00, Yes UpMDef, MType Cart, Build X:250 / Y:210 / Z:210,
Orig X:0 / Y:0 / Z:0, Home X:Min / Y:Min / Z:Min, Flip No X, Yes Y, No Z,
THeadOffsets [Tool 0] X:0 / Y:0,
Yes UpdFirm, FType RepRap, GPX: Replicator 2, Baud 115200

Scripts: Starting Script and Ending Script (see below), others blank
ExpFmt: Standard G-Code, No AddCeleb, AddTermCmd: (none)

```
// Max Print Speed = Max Volume / (Extrusion Width × Layer Height)
//                 = 10 mm³/sec / (0.4 mm × 0.1 mm)
//                 = 250 mm/sec
// Min Print Speed = 6 mm/sec (based on “Bulge Jam” scenario)
```

Speeds: SpDefault 4800 mm/min (= 80mm/sec), *// Core profiles range 1,800–12,000 mm/min*
SpPerim 50% (@SpDefault of 4800 mm/min → 2400 mm/min = 40 mm/sec),
SpSolidIn 80% (@SpDefault of 4800 mm/min → 3840 mm/min = 64 mm/sec),
SpSupp 80% (@SpDefault of 4800 mm/min → 3840 mm/min = 64 mm/sec),
SpXY 4800 mm/min (= 80 mm/sec), *// S3D was 12000. Don't really need to go blazing around …*
SpZ 600 mm/min (= 10 mm/sec), *// S3D was 1000. Be kind to your Z axis …*
Yes AdjBelow, AdjBelowSec 15,
AdjDown 30% (@SpDefault of 4800 mm/min → 1440 mm/min = 24 mm/sec,
@SpPerim of 2400 mm/min → 720 mm/min = 12 mm/sec)

Other: Area 50,
ExInflat 1.00, *// Extra support for bridging (Warkocki & Jo Prusa profiles)*
BrExMult 100%,
BrSpMult 100% (@SpDefault of 4800 mm/min → 4800 mm/min = 80 mm/sec),
No FixedAngle 0°,
Yes BrPerim, *// This seems like a smart idea … not sure why S3D has it off*
HComp 0.00, F-List [Tool 0] FilDiam 1.75, FilPrice 46.00, FilDen 1.25,
ChgRetDist 12, ChResDist -0.50, ChRetSp 600

Advanced: No Start 0.00, No Stop 0.00,

// Tried this, but it failed badly at the top (proximal) edge of the printed bird … extruded a bunch of "grit".
// HOWEVER … need to address how this could be used for the splitting edge – where we might
*// **want** a single-wall extrusion.*
// ExThinType AllowSingWall, // Allow a wall with only a single extrusion

ExThinType PerimOnly, *// Force full perimeters to be printed (S3D Default)*

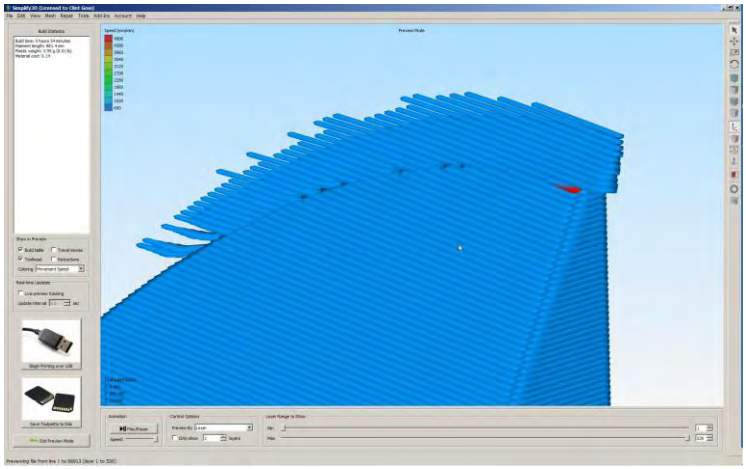
InThinType AllowSingExtr, *// Allow internal fills using a variable-width single extrusion*
Overlap 40%, *// Permit more combining of infills (default is 25%)*
MinExLen 1.00, MinPWid 50%, MaxPWid 200%,
EndExtDist 0.40, *// S3D was 0.20. Naver blog suggestions "usually = nozzle size"*
Yes Open, Yes ForceRet, No MinTRetr 3.00, Yes RetWipe, Yes WipeOuter,
Yes AvoidCross, *// Seems like a good idea*
MaxDetour 5.0, *// S3D was 3.0. Jo Prusa uses 5.0*
NonManSeg Heal, No Merge

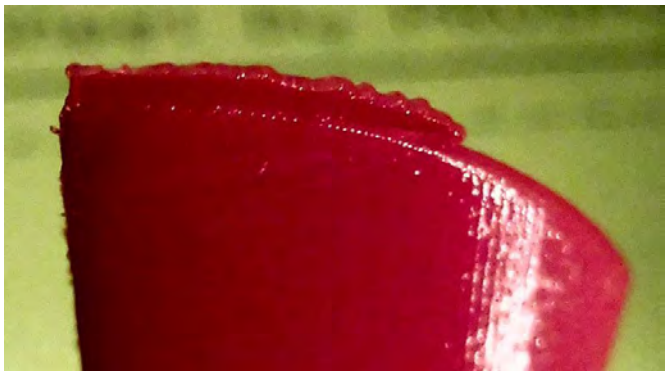
5/3/2018 Print of v73 BirdHalf in Rigid.Ink Red PLA

Updated design v73 using Rigid.Ink Red PLA with new Breath Flute-Specific profile.

- **Printed:** May 3, 2018
- **Source:** `BFlute_073.scad`
- **STL:** `BFlute_073_CG125pF3_BIH_20180501_1415.stl` (479 KB)
- **Factory:** `BFlute_073_CG125pF3_BIH_20180501_1415.factory`
- **Profile:** `Pi3Mk3_BF_CG_as0f20180503a.fff`
- **Based on:** `Pi3Mk3_BF_CG.fff`
- **G-code:** `BFlute_073_CG125pF3_BIH_20180501_1415.gcode` (1.8 MB)
- **Slicer:** Simplify3D 4.0.1. Profile modifications:
  - **Additions:** SkOffset 1.00
  - **Advanced:** ExThinType AllowSingWall
- **Printer:** Pi3Mk3/CG, 0.40mm brass E3D nozzle
- **Filament:** Rigid.Ink Red PLA 1.75m
- **Predic build time:** 0h 54m, Fil. length: 911 mm, Plastic weight: 2.95g (0.01 lb), Cost 0.14.
- **Actual build time:** 1h 01m
- **Printed part marked:** *(not marked)*

Results: Significant "grit" at the top of the bird. See below. Turned out to be the ExThinType setting, which was restored back to the default PerimOnly setting for the next print.





Also, consider moving the printing on the top of the bird over to the side when printing the BIH component – it is currently cut in half. *DONE – 5/3/2018.*

5/3/2018 Print of Revised v73 BirdHalf in Rigid.Ink Red PLA

Updated BIH design (rotated label on the top) v73 using Rigid.Ink Red PLA with new Breath Flute-Specific profile.

- **Printed:** May 3, 2018
- **Source:** `BFlute_073.scad`
- **STL:** `BFlute_073_CG125pF3_BIH_20180503_1016.stl` (985 KB)
  (why such an increase from last time??)
- **Factory:** `BFlute_073_CG125pF3_BIH_20180503_1016.factory`
- **Profile:** `Pi3Mk3_BF_CG_as0f20180503b.fff`
- **Based on:** `Pi3Mk3_BF_CG.fff`
- **G-code:** `BFlute_073_CG125pF3_BIH_20180503_1016.gcode` (1.8 MB)
- **Slicer:** Simplify3D 4.0.1. Profile modifications:
  - **Additions:** SkOffset 1.00
- **Printer:** Pi3Mk3/CG, 0.40mm brass E3D nozzle
- **Filament:** Rigid.Ink Red PLA 1.75m
- **Predic build time:** 0h 54m, Fil. length: 982 mm, Plastic weight: 2.95g (0.01 lb), Cost 0.14
- **Actual build time:** 1h 2m
- **Printed part marked:** *(not marked)*

Results: Worked Great!

Need to move the skirt further away from the part. It picks up blobs at the start, and those blobs could interfere with the print. Maybe 4mm (the default S3D setting) rather than 1mm? *DONE – 5/4/2018.*

5/4/2018 Rigid.ink Black PLA 1.75 Unwound Spool

Email to "Monica, rigid.ink Customer Service" customerdelight@rigid.ink on Fri, May 4, 2018 at 3:54 AM:

> Well ... so ... I haven't seen this before, but I'm pretty new to all this.
>
> Opened up your rigid.ink Black 1.75 PLA and it was completely unwound. Not your typical 1-2 dozen layers ... the whole spool. Sloshes around like a bowl of Jell-O.
>
> One end of the filament is threaded through two holes of the spool near the outermost radius, near the edge of the spool. However, the filament from that point leads to a thread way down near the core. There is no other threading of filament into any spool holes.
>
> Not sure what to do. Can't risk printing, because the only end I can find (the one threaded through the spool holes) goes deep into the roll. Don't see unrolling the entire 1/3 Km of filament onto the floor, and don't have a spare empty spool to roll it onto.
>
> Please advise ...

I subsequently checked the other two spools from the same order – translucent blue and natural – and they seem AOK.

5/4/2018 Print of v73 BodyProxHalf in Prusa Grey PLA

BPH v73 using Prusa Grey PLA with new Breath Flute-Specific profile.

- Printed: May 4, 2018
- Source: `BFlute_073.scad`
- STL: `BFlute_073_CG125pF3_BPH_20180501_1415.stl` (15.6 MB)
- Factory: `BFlute_073_CG125pF3_BPH_20180501_1415.factory`
- Profile: `Pi3Mk3_BF_CG_as0f20180504a.fff`
- Based on: `Pi3Mk3_BF_CG.fff`
- G-code: `BFlute_073_CG125pF3_BPH_20180501_1415.gcode` (11.9 MB)
- Slicer: Simplify3D 4.0.1. Profile modifications: *(none)*
- Printer: Pi3Mk3/CG, 0.40mm brass E3D nozzle
- Filament: Prusa Grey PLA 1.75m
- Predic build time: 3h 12m, Fil. length: 7.182 m, Plastic weight: 21.60g (0.05 lb), Cost 0.99
- Actual build time: ***Failed*** at 2h 44m
- Printed part marked: *(not marked)*

Results: ***Failed*** at 2:44 into the print. 80% the way up the ramp, the print head appears to have gotten stuck into a blob area. It extruded some "in the air" filament. There is also evidence of a bit of the prior color (red) from someplace on the extruder. Part popped off the bed while I was watching it.

Peg Cylinder Rotation

Wondering if we should rotate the five peg holes differently … more towards the front? The back one can stay centered … the two back ones could slide another 10° forward and the two front ones another 20° forward. *DONE – 5/4/2018 …*

Changed angles from +-72°, +-126°, and +180°. These were symmetric and avoided the "Breath Flute" imprint on the side of the body. However, I felt that a bolt more forward would give better strength. However, could only do that on one side.

Changed to these asymmetric angles:

- Left side (side with the "Breath Flute" imprint): -72°, -126°
- Right side: +60°, +120°
- Back: 180°

Also … consider moving the peg cylinder for the back peg (180°) a smidge just for the `BodyProxHalf` and `BodyDistHalf` components so that it sets ***slightly*** into the model and allows a set screw to be inserted for demonstration purposes. *DONE – 5/4/2018: changed from 180° to 175.5° for just these two components … AND had to add a bit of code to clear out the top of the peg cylinder so that it does not create a negative overhang (print-in-air).*

5/4/2018 Print of v73 BodyProxHalf in Rigid.Ink Translucent Blue PLA

BPH v73 using Rigid.Ink Translucent Blue PLA with Breath Flute-Specific profile.

- **Printed:** May 4, 2018
- **Source:** `BFlute_073.scad`
- **STL:** `BFlute_073_CG125pF3_BPH_20180501_1415.stl` (15.6 MB)
- **Factory:** `BFlute_073_CG125pF3_BPH_20180501_1415.factory`
- **Profile:** `Pi3Mk3_BF_CG_as0f20180504a.fff`
- **Based on:** `Pi3Mk3_BF_CG.fff`
- **G-code:** `BFlute_073_CG125pF3_BPH_20180501_1415.gcode` (11.9 MB)
- **Slicer:** Simplify3D 4.0.1. Profile modifications: *(none)*
- **Printer:** Pi3Mk3/CG, 0.40mm brass E3D nozzle
- **Filament:** Rigid.Ink Transcucent Blue PLA 1.75m
- **Predic build time:** 3h 12m, Fil. length: 7.182 m, Plastic weight: 21.60g (0.05 lb), Cost 0.99
- **Actual build time:** The displayed print time was not relevant, since it included the pause time.
- **Printed part marked:** *(not marked)*

This print was paused at height 32.25mm for about two hours while I went out. Resumed and seemed to pick right up where I left off. During pauses, the extruder cools but the heatbed is kept on. Resume initiates a heat cycle before it resumes printing.

Results: ***Excellent!*** Paused area does show some discoloration.

Consider carving out a small triangle – a "Crown" – at the head of the BodyProx nest area where there is a direct 90° bridge overhang. *DONE! – 5/4/2018: using the new Crown () module.*

5/4/2018 Print of v73 BodyDistHalf in Prusa Grey PLA

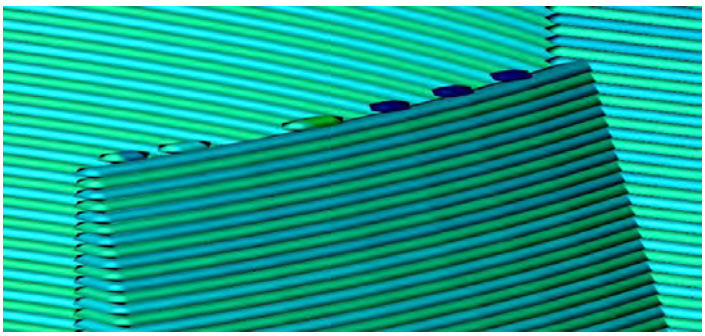
BDH v73 using Prusa Grey PLA with Breath Flute-Specific profile.

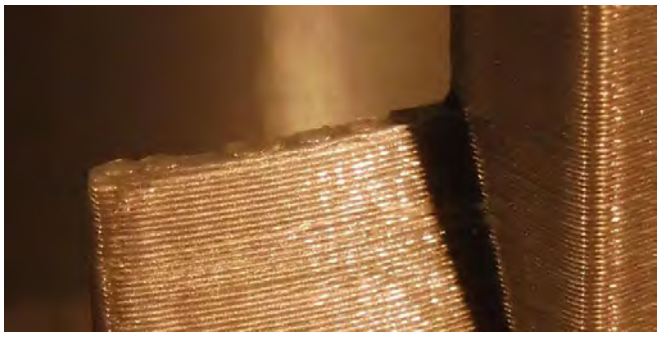
- **Printed:** May 4, 2018
- **Source:** `BFlute_073.scad`
- **STL:** `BFlute_073_CG125pF3_BDH_20180501_1415.stl` (15.6 MB)
- **Factory:** `BFlute_073_CG125pF3_BDH_20180501_1415.factory`
- **Profile:** `Pi3Mk3_BF_CG_as0f20180504a.fff`
- **Based on:** `Pi3Mk3_BF_CG.fff`
- **G-code:** `BFlute_073_CG125pF3_BDH_20180501_1415.gcode` (11.9 MB)
- **Slicer:** Simplify3D 4.0.1. Profile modifications: *(none)*
- **Printer:** Pi3Mk3/CG, 0.40mm brass E3D nozzle
- **Filament:** Prusa Grey PLA 1.75m
- **Predic build time:** 3h 2m, Fil. length: 7.862 m, Plastic weight: 23.64g (0.05 lb), Cost 1.09
- **Actual build time:** 3h 36m
- **Printed part marked:** *(not marked)*

Results: ***Excellent!*** … However, there is "grit" on the splitting edge …

> What if we set it up so that the start-end points were inside the inlay channel! i.e. underneath the inlay!! ***TBD***

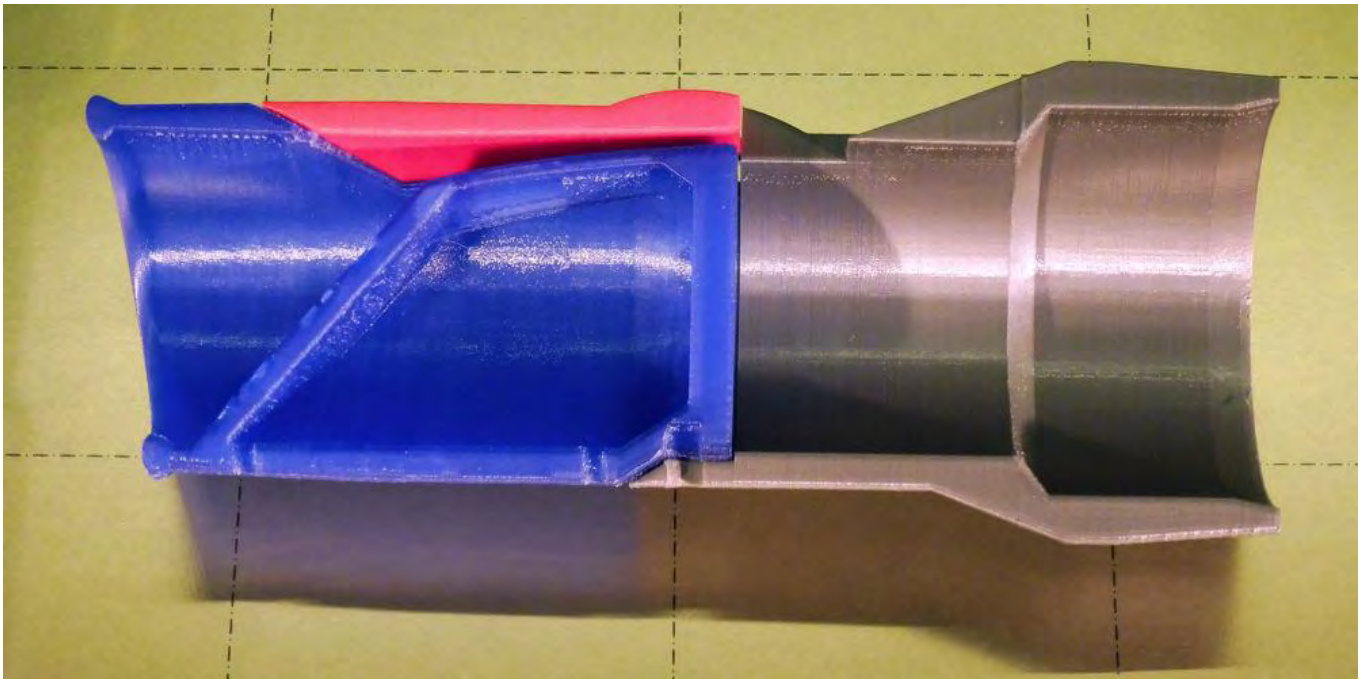
Need to issue caution about the integrity of the splitting edge when slicing … for example … the "grit" on this sliced splitting edge, as shown in the slicer:





Need to figure out how to get certain features, such as the splitting edge, to come out at exact heights. Need to consider FHt setting (currently 150 micros) and LHt (100 microns) and calc the stations accordingly. *DONE – 5/5/2018.*

The three v73 Half components were assembled with two Fastenal SKU 25116 #6-32 × ¼″ Hex Drive Flat Point Black Oxide Finish Alloy Steel Socket Set Screws and CA Glue for the Bird:



Breath Flute #74 – Improvements Beginning 5/5/2018

The issues addressed in this version …

- *(implemented during v73 development)* Move the printing on the top of the bird over to the side when printing the BIH component – it is currently cut in half. *DONE – 5/3/2018.*
- *(implemented during v73 development)* Adjust peg cylinder positions for the `BodyProxHalf` and `BodyDistHalf` components so that it sets ***slightly*** into the model and allows a set screw to be inserted for demonstration purposes. *DONE – 5/4/2018: see Peg Cylinder Rotation above.*
- *(implemented during v73 development)* Adjust peg cylinder positions for better strength. *DONE – 5/4/2018 … see notes above.*
- *(implemented during v73 development)* New "Crown" carve-out at the head of the BodyProx nest area. *DONE! – 5/4/2018: using the new Crown () module.*
- Need to initiate a document – or a video? – for fabricators … people printing Breath Flutes from STL. Lots of suggestions … the new `ZAlign` parameter for `BodyDist` (two digits with the number of microns mod 100 that the Splitting Edge is aligned. "100" = perfectly aligned, "50" for a FHt setting of 150% with LHt 0.10. ***TBD***
- Implement the new ZAlign parameter and print it on the inside of the `BodyDist` component and on the `SpEdge` component! *DONE – 5/5/2018.*
- A new `SpEdge` component with code SE to print out just the splitting edge for testing purposes. *DONE – 5/5/2018.*
- New `XYFactor` parameter to directly control the expansion of the Mortice ID (rather than the Material parameter, which was indirect). Need per mille factors such as 005 for 0.5% expansion to compensate for shrinkage. Print on inside of the `BodyDist` component as well as the `Foot` component. *DONE – 5/5/2018.*
- Completely overhaul the STL naming conventions … documented in the top-level ReadMe.txt file. *DONE – 5/5/2018.*
- Rework components so that they OpenSCAD models render faster. `SpEdge` is a prime candidate – it currently takes 25 minutes to render and 3 minutes to print! Foot is another one – 24 minutes to render. *DONE – 5/6/2018 – from 25 minutes to 1 minute.*
- What if we set it up so that the start-end points were inside the inlay channel! i.e. underneath the inlay!! ***TBD***
- Consider fixing the `Bird` to the `BodyProx` with Fastenal set screws! Maybe in the next version … ***TBD***
- May need a custom Brim for the `Bird` component, specifically to not attach the brim on the underside of the flue exit (where it would interfere with the chamfer), but attach it on all other quadrants, including the underside on the sides, where they can be filed off flat. ***TBD***

5/6/2018 Nozzle Change 0.40 → 0.50mm

Attempted nozzle changes … needed help!

```
Filip 6:16 am Hello. How may I help you?
Clint Goss 6:18 am Hi ... Changing nozzle for the first time on an assembled
printer, no I'm new to this. Got fan and covers off OK. Concern: the block and
the big thing with fins above it (the heatsink?) are very very loose. They
wiggle around a lot, like they are not really connected or loose. Is that OK?
Normal? THANKS for handling this ...
Filip 6:18 am hi, what have you removed together with the fan shroud?
6:19 am the "covers"
Clint Goss 6:19 am Remove bottom piece, and the front fan (print fan?) and the
cover over the heat sink and block
Filip 6:20 am ok
it can be a bit loose because you removed the extruder body part
don't worry about it, you wil have to hold the heater block with something
anyway
https://help.prusa3d…6-changing-or-replacing-nozzle Changing or replacing the
nozzleInstructions for replacing your brass or Olsson Ruby nozzle.
6:21 am it might look different, but the overall process is identical
Clint Goss 6:22 am Filip ... THANKS ... also ... are there updated nozzle
changing instructions. Those instructions you referenced have parts that don't
look like mine, and the tool sizes seem to have changed
Filip 6:22 am if you have mk3
Clint Goss 6:22 am Yes ... mk3
Filip 6:22 am just make sure to preheat, hold the block and you're set
Clint Goss 6:23 am OK ... thank you SO much Filip ... glad this isn't brain
surgery – could you imagine?
Filip6:24 am lucky thats just the printer ;)
Clint Goss 6:25 am "Hi – Surgery LiveChat? Yes, I got this grey thing over the
top of another grey thing ... I'm not sure which one to cut ..."
Filip 6:28 am Hold on, let me ask my friend about this one... ;)
6:29 am Is there anything else I can help you with?
Clint Goss 6:29 am All Set ... THANKS!
Filip 6:29 am Good luck
```

Subsequently sent this on the Prusa user forum:

Sun May 06, 2018 7:52 am – Firmware Needs to Know Nozzle Size?

Does the firmware need to know what size nozzle is installed? Have I missed this somewhere??

For things like Calibration => First Layer Cal. ... isn't this important?

I just changed the MK3 nozzle 0.40 => 0.50

Experienced folks will chuckle ... but changing nozzles for the first time is a moderately cheek-clenching experience for a newbie who got the printer assembled. The instructions and images are outdated, the tool-size suggestions were way off, and there's an all-around lack of details (compared with the extensively detail Kit Construction manual).

Some issues:

- Step #1: Unload filament. (cue the experienced folks chuckling and rolling on the floor in laughter).
- The Heatsink and extruder block wobble excessively during nozzle installation, which caused me alarm to the point where I contacted support (which were great and did their best to hide their chuckling).
- When installing the new nozzle, the extruder block does not line up along the Y axis unless you position it there with an adjustable crescent wrench.
- Re-installing the PETG front shield is a bit tortuous given that the extruder stepper motor wires needed to be threaded into the channel. I did consult the Kit Construction manual for this, but it uses a different build sequence and routes this cable much earlier.
- Also ... how 'bout letting people cooling down the hotend after the nozzle is installed and before re-installing the parts. Might save some burns ...

It would be ***great*** to have a mini-manual on this with commenting and live editing - along the lines of the Kit Construction manual.

… then subsequently got a pointer to this video, which would have helped:
https://www.youtube.com/watch?v=iEKR8ZnFsUA

5/6/2018 Pi3Mk3_BF_CG_Noz50 Breath Flute Profile for 0.50mm Nozzle

Based on `Pi3Mk3_BF_CG.fff / PLA / High` with changes for a 0.50mm nozzle for Corkfill.

Some of the advice is based on https://learn.colorfabb.com/how-to-print-with-corkfill/ … noted in the comments below as *// CFHowTo*. Here are the parameters for `Pi3Mk3_BF_CG_Noz50` that differ from `Pi3Mk3_BF_CG` shown in red:

Profile: `Pi3Mk3_BF_CG_Noz50.fff / PLA / High`

Extruder: Noz 0.50, ExtWid Man 0.50,
RetrDist 2.00, *// 1.00→2.00. CFHowTo recommends 4.5mm, but that's for a Bowden tube UM2+*
RSpeed 2700 mm/min (= 45 mm/sec), *// 2400→2700. CFHowTo recommends 45 mm/sec = 2700*

Layer: *(no changes)*

Additions: *(no changes)*

Infill: *(no changes)*

Support: *(no changes)*

Temp: [PrimExtr] SetP 1:215°C / 2:210°C, *// Based on CFHowTo of 210–225°C*
[HBed] SetP 1:60°C / 2:55°C *// Based on CFHowTo of 50–60°C*

Cooling: *(no changes)*

G-Code: *(no changes)*

Scripts: *(no changes)*

Speeds: SpXY 12000 mm/min (= 200 mm/sec), *// 4800→12000. CFHowTo rec 200 mm/sec to combat stringing*

Other: *(no changes)*

Advanced: *(no changes)*

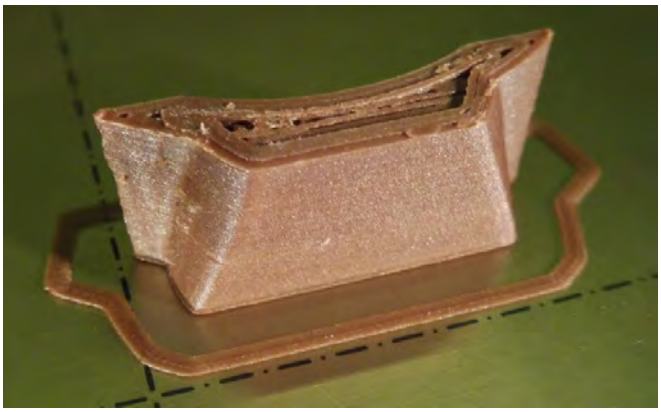
5/6/2018 Print of XYZ20mmCalibrationCube in Corkfill

XYZ20mmCalibrationCube using Corkfill.

- **Printed:** May 6, 2018
- **Source:** https://www.thingiverse.com/thing:2790787
- **STL:** `xyzCalibration_cube.stl` (7 KB)
- **Factory:** `XYZ20Cube_20180408_S3D_Pi3Mk3_Ckfill_30pct.factory`
- **Profile:** `Pi3Mk3_BF_CG_Noz50_30pct.fff`
- **Based on:** `Pi3Mk3_BF_CG_Noz50.fff / PLA / High` (see above)
- **G-code:** `XYZ20Cube_20180506_S3D_Pi3Mk3_Ckfill_30pct.gcode` (437 KB)
- **Slicer:** Simplify3D 4.0.1. Profile modifications:
  - **Infill:** Infill 30%
- **Printer:** Pi3Mk3/CG, 0.50mm brass E3D nozzle
- **Filament:** ColorFabb Corkfill 1.75m
- **Predic build time:** 0h 50m, Fil. length: 1.915 m, Plastic weight: 5.76g (0.01 lb), Cost 0.26
- **Actual build time:** 0h 58m
- **Printed part marked:** *"8"*

Results: ***Excellent!***

5/6/2018 Print of Bird in Corkfill at Noz 0.50



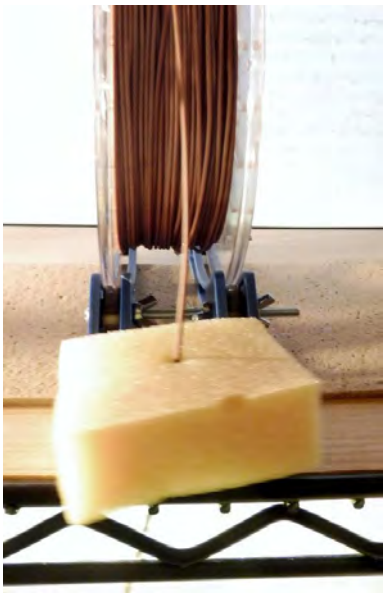
BI v74 using Corkfill with on a 0.50 mm nozzle with the Breath Flute-Specific profile.

- **Printed:** May 6, 2018
- **Source:** `BFlute_074.scad`
- **STL:** `BFlute_074_BI125F_CG_20180505_1526.stl` (850 KB)
- **Factory:** `BFlute_074_BI125F_CG_20180505_1526.factory`
- **Profile:** `Pi3Mk3_BF_CG_Noz50.fff`
- **Based on:** `Pi3Mk3_BF_CG_Noz50.fff / PLA / High` (see above)
- **G-code:** `BFlute_074_BI125F_CG_20180505_1526.gcode` (3.2 MB)
- **Slicer:** Simplify3D 4.0.1. *(no modifications)*
- **Printer:** Pi3Mk3/CG, 0.50mm brass E3D nozzle
- **Filament:** ColorFabb Corkfill 1.75m
- **Predic build time:** 1h 33m, Fil. length: 1.995 m, Plastic weight: 6.00g (0.01 lb), Cost 0.28
- **Actual build time:** *(print failed)*
- **Printed part marked:** "A"

Results: ***Print Failed!*** Print jam about ¼ of the way up the print. Extruder gears clicking, no extrusion. Extracted the filament and it had a clog at the end – this is not a Bulge Jam due to slow printing. Was able

to clip out the filament blob from the side access port and clear the clogged nozzle with an acupuncture needle.

Filament Filter



Added a sponge filament filter to the setup to try to avoid clogs. No oil – just the filter.

5/7/2018 Print of Bird in Corkfill at Noz 0.50

Second attempt at BI v74 using Corkfill with Breath Flute-Specific profile.

- Printed: May 7, 2018
- Source: `BFlute_074.scad`
- STL: `BFlute_074_BI125F_CG_20180505_1526.stl` (850 KB)
- Factory: `BFlute_074_BI125F_CG_20180505_1526.factory` (same as last print)
- Profile: `Pi3Mk3_BF_CG_Noz50.fff`
- Based on: `Pi3Mk3_BF_CG_Noz50.fff / PLA / High` (see above)
- G-code: `BFlute_074_BI125F_CG_20180505_1526.gcode` (3.2 MB) (same as last print)
- Slicer: Simplify3D 4.0.1. No profile modifications … temp increase done with live tuning
- Printer: Pi3Mk3/CG, 0.50mm brass E3D nozzle
- Filament: ColorFabb Corkfill 1.75m
- Predic build time: 1h 33m, Fil. length: 1.995 m, Plastic weight: 6.00g (0.01 lb), Cost 0.28
- Live Tuning:
  - Increase Nozzle temperature (hotter is less clog-prone?) from 215°C to 220°C for the first layer, and 210°C to 215°C starting with layer 2 on up.
- Actual build time: *(print failed)*
- Printed part marked: "B"

Results: ***Print Failed!*** Print became unstuck from the bed. It seems to have been printing with no clog, just printed in the air. Needs a brim!

5/7/2018 Print of Bird in Corkfill at Noz 0.50

Third attempt at BI v74 using Corkfill at Noz 0.50.

- Printed: May 7, 2018
- Source: `BFlute_074.scad`
- STL: `BFlute_074_BI125F_CG_20180505_1526.stl` (850 KB)
- Factory: `BFlute_074_BI125F_CG_20180505_1526_Print20180507.factory`
- Profile: `Pi3Mk3_BF_CG_Noz50_Bird.fff`

- **Based on:** `Pi3Mk3_BF_CG_Noz50.fff / PLA / High` (see above)
- **G-code:** `BFlute_074_BI125F_CG_20180505_1526_Print20180507.gcode` (3.1 MB)
- **Slicer:** Simplify3D 4.0.1. Profile modifications:
  - **Temp:** [PrimExtr] SetP 1:220°C / 2:215°C, *// ColorFabb HowToPrintWithCorkfill 210–225°C*
    [HBed] SetP 1:60°C / 2:55°C *// ColorFabb HowToPrintWithCorkfill 55°C*
  - **Additions:** SkOffset 0.00, SkOutlines 10
- **Printer:** Pi3Mk3/CG, 0.50mm brass E3D nozzle
- **Filament:** ColorFabb Corkfill 1.75m
- **Predic build time:** 1h 34m, Fil. length: 2.014 m, Plastic weight: 6.06g (0.01 lb), Cost 0.28
- **Actual build time:** *(print failed)*
- **Printed part marked:** "C"

Results: ***Print Failed!*** Filament jammed maybe 4–8 layers up … not a bulge jam, but probably a nozzle jam with extruder gears clicking. Was able to unload and looked like a cold (atomic) pull with a blob at the end.

5/7/2018 Rotation Visualizer Failure

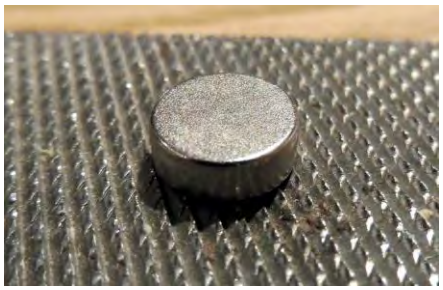
The rotation visualizer I printed in mid-April (one of the first prints on Pi3Mk3/CG) failed with annoying consequences.

Posted on the Prusa forum:

In mid-April, I printed a rotation visualizer in MatterHackers Pro PLA and fixed it to a Rare Earth magnet with CA glue with no surface preparation. Things went fine until today, when it failed with annoying consequences:

- The printed PLA part had warped, although I did not realize it. Not sure why – extruder stepper motor heat or heat rising from the extruder? This made the part rub against the body of the extruder stepper motor, which may have contributed to …
- The CA glue bond holding the PLA part to the magnet failed.

Getting the magnet off of the axle of the extruder stepper motor was no picnic. It refused being grasped by pliers, vice-grips, or any "grabber" type tools, because of the miniscule clearance above the body of the stepper motor. I eventually succeeded by sticking it to 3M VHB double-sided adhesive (back of a GoPro mounting bracket).



The glue bond may have failed due to lack of surface prep. I am now running both the metal and plastic parts over a coarse file prior to gluing. After gluing on one magnet, I re-installed the part and realized it was warped and rubbing against the body of the extruder stepper motor.

The warping can be seen in this picture, as well as the two magnets – both CA-glued – which I am now using to raise the visualizer away from the extruder stepper motor.

5/8/2018 Nozzle Change 0.50 → 0.60mm

Cleaned the 0.50mm nozzle with an acupuncture needle and installed the 0.60mm nozzle.

5/8/2018 Print of Bird in Corkfill at Noz 0.60

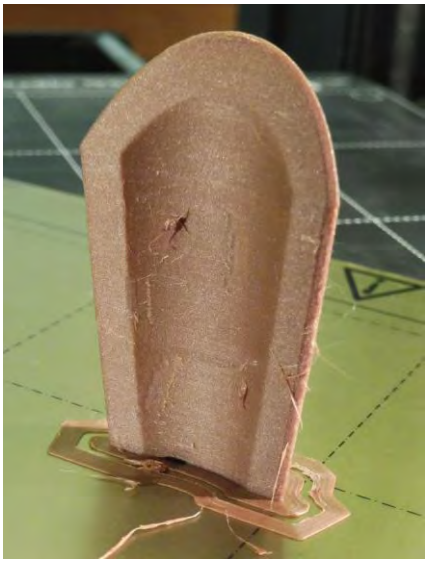
First attempt at BI v74 using Corkfill on a 0.60mm nozzle with Breath Flute-Specific profile.

- Printed: May 8, 2018
- Source: `BFlute_074.scad`
- STL: `BFlute_074_BI125F_CG_20180505_1526.stl` (850 KB)
- Factory: `BFlute_074_BI125F_CG_20180505_1526_Noz060_20180508.factory`
- Profile: `Pi3Mk3_BF_CG_Noz60_Bird.fff`
- Based on: `Pi3Mk3_BF_CG.fff / PLA / High` (see above)
- G-code: `BFlute_074_BI125F_CG_20180505_1526_Noz060_20180508.gcode` (3.1 MB)
- Slicer: Simplify3D 4.0.1. Profile modifications:
  - Extruder: Noz 0.60, ExtWid Man 0.60,
    RetrDist 2.00, *// 1.00→2.00. CFHowTo recommends 4.5mm, but that's for a Bowden tube UM2+*
    RSpeed 2700 mm/min (= 45 mm/sec), *// 2400→2700. CFHowTo recommends 45 mm/sec = 2700*
  - Additions: SkOffset 0.00, SkOutlines 10
  - Temp: [PrimExtr] SetP 1:220°C / 2:215°C, *// ColorFabb HowToPrintWithCorkfill 210–225°C*
    [HBed] SetP 1:60°C / 2:55°C *// ColorFabb HowToPrintWithCorkfill 55°C*

Speeds: SpXY 12000 mm/min (= 200 mm/sec), *// 4800→12000. CFHowTo rec 200 mm/sec to combat stringing*

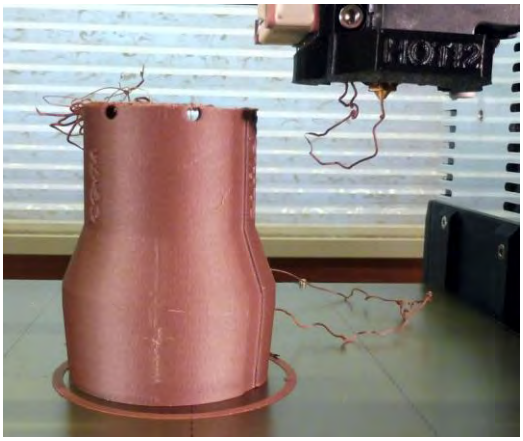
- Printer: Pi3Mk3/CG, 0.60mm brass E3D nozzle
- Filament: ColorFabb Corkfill 1.75m
- Predic build time: 1h 25m, Fil. length: 1.980 m, Plastic weight: 5.95g (0.01 lb), Cost 0.27
- Actual build time: 1h 34m
- Printed part marked: "??"

Results: It worked! Some stringing, and ghosting around the front inset lettering, but it didn't jam!



Notice that the brim is "interrupted". This is the result of a Pause in the print to clear a bit of hanging filament. During the Pause, a noticeable amount of filament oozed out of the nozzle, and it took that much space in the brim to "re-prime" the nozzle and resume extruding filament.

5/8/2018 Print of BodyDist in Corkfill at Noz 0.60

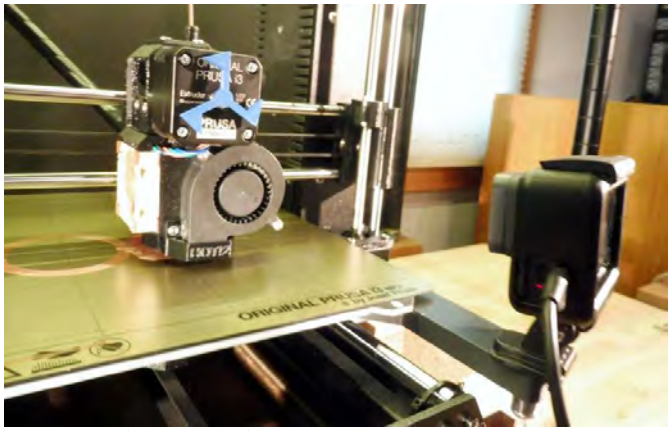


First attempt at BD v74 using Corkfill on a 0.60mm nozzle with Breath Flute-Specific profile.

- Printed: May 8, 2018
- Source: `BFlute_074.scad`
- STL: `BFlute_074_BD125F_CGi3z5e5_20180505_1526.stl` (7.0 MB)
- Factory: `BFlute_074_BD125F_CGi3z5e5_20180505_1526_Noz060_20180508.factory`
- Profile: `Pi3Mk3_BF_CG_Noz60_Body.fff`
- Based on: `Pi3Mk3_BF_CG_Noz60_Bird.fff` (see above)
- G-code: `BFlute_074_BD125F_CGi3z5e5_20180505_1526_Noz060_20180508.gcode` (22.3 MB)
- Slicer: Simplify3D 4.0.1. Profile modifications:
  - Additions: SkOffset 3.00, SkOutlines 4
- Printer: Pi3Mk3/CG, 0.60mm brass E3D nozzle
- Filament: ColorFabb Corkfill 1.75m
- Predic build time: 3h 23m, Fil. length: 16.124 m, Plastic weight: 48.48g (0.11 lb), Cost 2.23
- Actual build time: *(print failed) at 4h 26m*
- Printed part marked: "??"

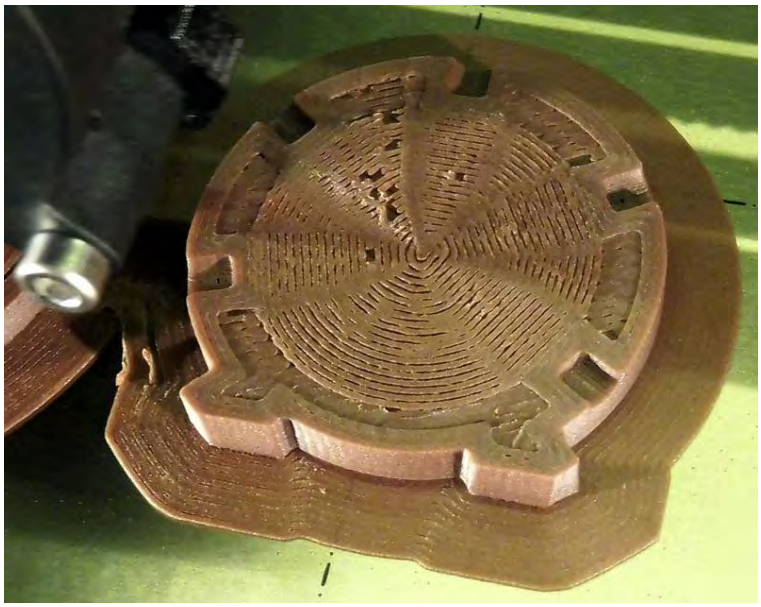
Results: ***Print Failed!*** It came unstuck from the build plate at 90+% of the way through – at the peg cylinders. Was off to the side with the printer air-printing. Sigh.

5/8/2018 Print of BodyDist and BodyProx in Corkfill at Noz 0.60



BD and BP v74 using Corkfill on a 0.60mm nozzle with Breath Flute-Specific profile, and a GoPro Time Lapse recording!

- **Printed:** May 8, 2018
- **Source:** `BFlute_074.scad`
- **STL:** `BFlute_074_BD125F_CGi3z5e5_20180505_1526.stl` (7.0 MB)
  `BFlute_074_BP_CG_f125i3_20180508_0909.stl` (31.8 MB)
- **Factory:** `BFlute_074_BD_BP_Noz060_20180508.factory`
- **Profile:** `Pi3Mk3_BF_CG_Noz60_Bird.fff`
- **Based on:** `Pi3Mk3_BF_CG_Noz60_Bird.fff` (see above)
- **G-code:** `BFlute_074_BD_BP_Noz060_20180508.gcode` (44.6 MB)
- **Slicer:** Simplify3D 4.0.1. Profile modifications: *(no modifications)*
  Note that this is the Bird profile, the one that uses a brim.
- **Printer:** Pi3Mk3/CG, 0.60mm brass E3D nozzle
- **Filament:** ColorFabb Corkfill 1.75m
- **VidSetup:** GoPro5 Black, Time-Lapse video, Res 1080, Intervals 60s, Zoom NAR (Narrow)
- **Video:** `Video/BFlute_074_BD_BP_Noz060_20180508_GOPR0005.mp4`
- **Predic build time:** 6h 16m, Fil. length: 30.648 m, Plastic weight: 92.15g (0.20 lb), Cost 4.24
- **Actual build time:** 8h 27m
- **Printed part marked:** (none)



GoPro 5 Black Setup, mounted on the right front corner of the build plate, near far edge of Black ABS plastic bracket. Settings:

- Time Lapse Video
- 1080 resolution
- 60s intervals
- Narrow (NAR) zoom factor

Results: ***It worked!***

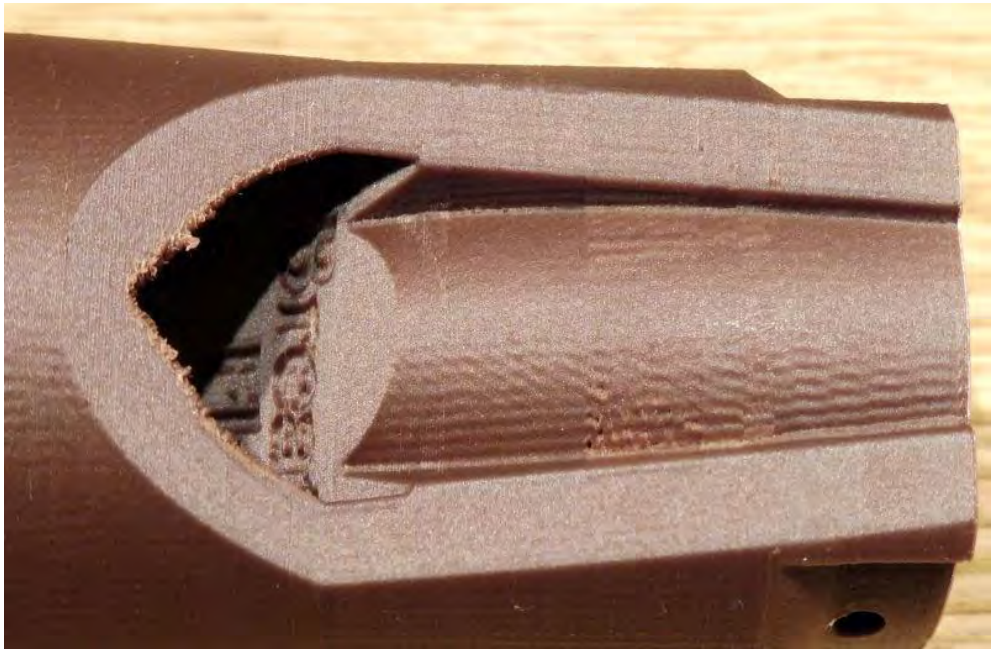
Noticed voids during the print. Posted an email query on the Prusa forum asking for advice.

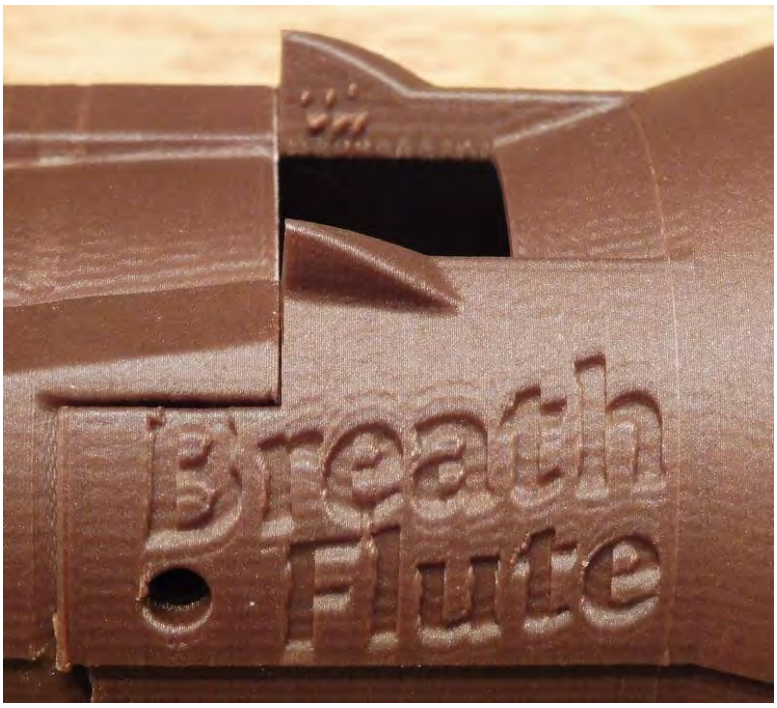
The pictures below are from the final print, interspersed with notes about issues that they highlight:

- The right image above, from the back of the `BodyDist` component, shows a straight-line marking (I think) the location of the extruder Start-Stop points.

- The image above shows voids on the surface of the print, at the top edge of the `BodyDist` component. It may be similar / related to the voids observed in the infill during the print (photo above).

- The image at the right shows issues in the flue area: Continued grit / blobs at the crown area, ringing and moiré patterns on the floor of the flue.





- The image above shows blobs in the wall of the TSH on the far side. It also points out how poorly the "Breath Flute" lettering renders … consider moving it distally (onto the flare-out portion of the shell) and making it larger.

Review …

Review of materials used in all prior print efforts by Vera.

Short answer … try nGen again!

Breath Flute-Specific Pi3Mk3 Profile for nGen at LHt 0.40mm

On 5/9/2018, I decided to abandon Corkfill – too many issues for producing Breath Flutes:

- clogging (intermittent – causing gaps and holes – as well as print-ending)
- the need to use 0.60mm nozzles, reducing detail
- the low melt temperature, which could cause widespread failure of a set of headjoints if they get too hot during shipping
- The inability to sanitize in a dishwasher

A review of past printed parts led to a re-examination of ColorFabb nGen as a material. It is based on Eastman Amphora 3300 as the underlying material.

This profile is based on the core profile `Pi3Mk3 Pristine S3D 20180412.fff / PLA / High`

This profile is based on the core profile `Pi3Mk3_BF_CG.fff / PLA / High`, which in turn is based on the core profile `Pi3Mk3 Pristine S3D 20180412.fff / PLA / High`. Differences from `Pi3Mk3_BF_CG` are shown in purple, while difference from the earlier `Pi3Mk3 Pristine S3D 20180412.fff` are shown in red.

Some of the advice is based on recommendations for in the *Amphora 3D Polymer Consumer Selector Guide* by Eastman, file `Eastman_3DPolymer_ConsumerSelectionGuide_SPMBS4044.pdf` initially retrieved 5/18/2017 from https://www.eastman.com/Literature_Center/S/SPMBS4044.pdf (but still current as of 5/9/2018). Suggested settings from this document are marked with *// AmphoraCSG*.

Profile: `Pi3Mk3_BF_CG_nGen.fff / PLA / High`

Extruder: E-List [PrimExtr], Index Tool 0: Noz 0.40,
// AmphoraCSG: 99%–104% Start first layer at 150% [?is that FHt?] with a width of 120% and 40% speed.
ExtMult 1.00,
// Increased from 1.00×Noz to 1.15×Noz based on the use of a 1.2 factor as a default for S3D and
// Prusa forum user PJR that "generally extrusion width should be from 1 to 1.25 times the nozzle
// diameter" (May 2, 2018). See `S3D_SettingsCG.pdf` *for more info.*
ExtWid Man 0.46, *// Up from 0.40 in* `Pi3Mk3_BF_CG`.
Ooze Control: YES Retr,
// AmphoraCSG: 3mm Use suggested retraction distance with a 0.3 mm coast and 0.3 mm vertical lift.
RetrDist 3.00, *// Up from 1.00 in* `Pi3Mk3_BF_CG`
ExRestart 0.00,
// AmphoraCSG – from the Retraction Distance reco: … with a 0.3 mm coast and 0.3 mm vertical lift.
RVertLift 0.30, *// Up from 0.00 in* `Pi3Mk3_BF_CG`

// AmphoraCSG: 45 mm/sec (=2700 mm/min)
RSpeed 2700 mm/min (= 45 mm/sec), *// Up from 2400 in* `Pi3Mk3_BF_CG`
Yes Coast,
// AmphoraCSG – from the Retraction Distance reco: … with a 0.3 mm coast and 0.3 mm vertical lift.
CoastDist 0.30, *// Up from 0.20 in* `Pi3Mk3_BF_CG`
Yes Wipe, WipeDist 2.00

Layer: L-Extr: PrimExtr,
// Layer Height 0.1mm = 100um – good for visual quality. However, Infill=>Combine set to 2
// to print infill at 0.2mm, which has 24% better Yield Stress, [3DMATTER 2015]
// AmphoraCSG: 0.15–0.20 mm. Monitor the first layer to make sure no material sticks to the nozzle
// and accumulates. If the first layer has no buildup or skips in the layer, the rest of the print should
// be successful. Height ranges are for a 4 mm [sic] nozzle.
LHt 0.10, *// BELOW the minimum AmphoraCSG recommendation.*
TSolid 4, BSolid 4,
Shells 3, *// Highest Yield Stress, based on the [3DMATTER 2015] study*
Dir: InOut, No PISeq, No Vase,
// AmphoraCSG – from the Percent Flow reco: Start first layer at 150% [?is that FHt?]
FHt: 150%, *// S3D Default … works well for me. Jo Prusa & Jeff Golden use 200%*
// AmphoraCSG – from the Percent Flow reco: … with a width of 120%
FWid 120%, *// Up from 105% in* `Pi3Mk3_BF_CG`*. Chris Warkocki uses 102%*
// AmphoraCSG – from the Percent Flow reco: … and 40% speed.
// Up from 35% in `Pi3Mk3_BF_CG`
FSpeed 40% (@SpDefault of 3000 mm/min → 1200 mm/min = 20 mm/sec),
// Start on the back. For the Bird component, the seam will be in critical areas (roof of the flue,
// top curved bevel edge), but those areas require sanding in any case.
// Issue: As we move the print around on the bed to handle PEI bubbles … this needs to be adjusted!
StartPts: Choose, X:125.0 / Y:210.0 *// Back of model!*

Additions: Yes Skirt, Sk-Extr PrimExtr, SkLayers 1, SkOffset 3.00,
SkOutlines 4, *// Up from 2 in* `Pi3Mk3_BF_CG`
No Raft, R-Extr PrimExtr, Top 3, Base 2, ROffset 3.00, SepDist 0.14, TopInfill 100%,
SpAbRaft 30% (@SpDefault of 3000 mm/min → 900 mm/min = 15 mm/sec),
No Pillar, P-Extr AllExtr, PPWidth 12.00, PPLoc North-West,
PPSpMult 100% (@SpDefault of 3000 mm/min → 3000 mm/min = 50 mm/sec),
No Ooze O-Extr AllExtr, OOffset 2.00, OPerims 1, OShape Waterfall, OAngle 30°,
OSpMult 100% (@SpDefault of 3000 mm/min → 3000 mm/min = 50 mm/sec)

Infill: I-Extr PrimExtr,
IntPat Rect, *// Rectilinear for greatest Max Stress, based on the [3DMATTER 2015] study*
ExtPat Conc, *// Concentric, so that visible surfaces show arcs rather than lines*
Infill 90%, *// Infill for greatest Yield Stress, based on the [3DMATTER 2015] study*
OutOvr 25%, *// S3D is 20%, KeyboardWarrior 30%, Jo Prusa 25%*
InWid 100%,
MinLen 2.00, *// S3D is 5, Jo Prusa is 2, Chris Warkocki is 1.00*
Combine 2, *// Force infill to print at 0.2mm, which increases Yield Stress by 24% [3DMATTER 2015]*
No IncSolid, DiaphEvery 20,
IntAng: 0 / +50 / -25 / +25 / -50 / 90, *// Best Max Stress along longitudinal axis, [3DMATTER 2015]*
No EvAngle,
ExtAng: 45 / -45 *// This should not have any effect on slicing, since ExtPat is Concentric*

Support: No GenSupp, Sp-Extr PrimExtr, SuppInfill 40%, ExInflDist 0.00, BaseLayers 0, CombEvery 1,
DenseSupp D-Extr PrimExtr, DenseLayers 0, DenseInfill 70%,
APType Normal, APRes 4.00, APAngle 45°, HSep 0.30, UpLay 1, LowLay 1, SupAng 0

Temp: T-List [PrimExtr] T0, TType Extruder, No Layer, No Loop, Yes WaitStab,
// AmphoraCSG: 220°–250°C Start at low temperature and increase 5°C
// until desired flow and proper adhesion is established.
SetP 1:225°C / 2:220°C,
T-List [HBed] T0, TType HBPlat, No Layer, No Loop, Yes WaitStab,
// AmphoraCSG: 65°–85°C For best adhesion, use clear glass plate. Applying hair spray
// reduces the risk of pulling glass pieces from the surface.
SetP 1:70°C / 2:65°C

Cooling:
// AmphoraCSG: Engage cooling at 60% after layer 4. Recommended for regular print jobs requiring
// an average strength and speed. For best possible strength, it is advised to print with as little cooling
// as possible. This percent varies from printer to printer. Be careful using too much cooling: this
// combined with low print temperature and high speed could result in layer delaminating prints.
FanSpeed 1:0 / 4:60, *// From 1:0 / 2:100 in* `Pi3Mk3_BF_CG`
No Blip, No Incr, ITime 45sec, MxFSp 100%,
// AmphoraCSG: Plan to run the fan at 100% during bridging operations when attempting to print
overhangs or gaps without physical support. If bridging is done too quickly, break melt will occur.
However, if done too slowly, layers will start sagging.
Yes BrFan, BrSpOvr 100%

G-Code: Yes 5D, No RelDist, Yes AllowZ, No Indep, No M101, Yes Sticky, No applyGOffsets,
GOffsets X:0.00 / Y:0.00 / Z:0.00, Yes UpMDef, MType Cart, Build X:250 / Y:210 / Z:210,
Orig X:0 / Y:0 / Z:0, Home X:Min / Y:Min / Z:Min, Flip No X, Yes Y, No Z,
THeadOffsets [Tool 0] X:0 / Y:0,
Yes UpdFirm, FType RepRap, GPX: Replicator 2, Baud 115200

Scripts: Starting Script and Ending Script (see below), others blank
ExpFmt: Standard G-Code, No AddCeleb, AddTermCmd: (none)

```
// Max Print Speed = Max Volume / (Extrusion Width × Layer Height)
//                 = 10 mm³/sec / (0.4 mm × 0.1 mm)
//                 = 250 mm/sec
// Min Print Speed = 6 mm/sec (based on "Bulge Jam" scenario)
```

Speeds:
// AmphoraCSG: 40–60 mm/sec (=2400–3600 mm/min) Printing speed is typically similar to
// PLA setting on most machines.
// Core profiles range 1,800–12,000 mm/min
SpDefault 3000 mm/min (= 50 mm/sec), *// Down from 4800 mm/min* Pi3Mk3_BF_CG
SpPerim 50% (@SpDefault of 3000 mm/min → 1500 mm/min = 25 mm/sec),
SpSolidIn 80% (@SpDefault of 3000 mm/min → 2400 mm/min = 40 mm/sec),
SpSupp 80% (@SpDefault of 3000 mm/min → 2400 mm/min = 40 mm/sec),

// SpXY changed // 4800→12000 to combat stringing.
// This is similar to the CFHowTo article for ColorFabb Corkfill, another stringing-prone filament.
// Also, Tomas Sanladerer opined that:
// "Travel moves should always be as fast as your printer can handle, because it's going to give the
// hotend as little of a chance of oozing and going out of the intended plastic flow situation as possible
// if that makes sense. Your printer's firmware should know how fast it can reliably go, so you can
// actually set the travel speed on your slicer to some obscene value and let your printer handle the rest."
// https://toms3d.org/2018/02/05/things-know-petg/ and
// https://www.youtube.com/watch?v=8_adY2K-YIc
SpXY 12000 mm/min (= 200 mm/sec), SpZ 600 mm/min (= 10 mm/sec),
Yes AdjBelow, AdjBelowSec 15,
AdjDown 30% (@SpDefault of 3000 mm/min → 900 mm/min = 15 mm/sec,
 @SpPerim of 1500 mm/min → 450 mm/min = 7.5 mm/sec)

Other: Area 50,
ExInflat 1.00, *// Extra support for bridging (Warkocki & Jo Prusa profiles)*
BrExMult 100%,
// AmphoraCSG: 60 mm/sec. If bridging is done too quickly, break melt will occur.
// However, if done too slowly, layers will start sagging.
// Up from 100% in Pi3Mk3_BF_CG
BrSpMult 120% (@SpDefault of 3000 mm/min → 3600 mm/min = 60 mm/sec),
No FixedAngle 0°,
Yes BrPerim, *// This seems like a smart idea … not sure why S3D has it off*
HComp 0.00, F-List [Tool 0] FilDiam 1.75, FilPrice 46.00, FilDen 1.25,
ChgRetDist 12, ChResDist -0.50, ChRetSp 600

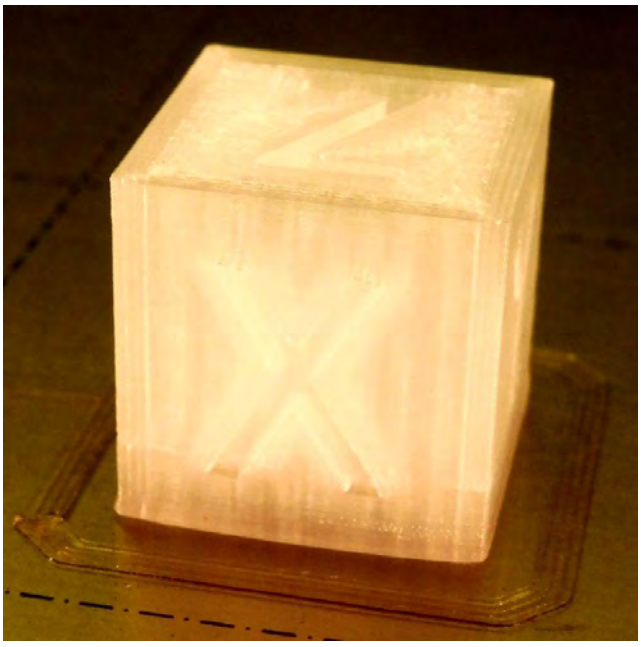
Advanced: No Start 0.00, No Stop 0.00,
ExThinType PerimOnly, *// Force full perimeters to be printed (S3D Default)*
InThinType AllowSingExtr, *// Allow internal fills using a variable-width single extrusion*
Overlap 40%, *// Permit more combining of infills (default is 25%)*
MinExLen 1.00, MinPWid 50%, MaxPWid 200%,
EndExtDist 0.40, *// S3D was 0.20. Naver blog suggestions "usually = nozzle size"*
Yes Open, Yes ForceRet, No MinTRetr 3.00, Yes RetWipe, Yes WipeOuter,
Yes AvoidCross, *// Seems like a good idea*
MaxDetour 5.0, *// S3D was 3.0. Jo Prusa uses 5.0*
NonManSeg Heal, No Merge

5/10/2018 Nozzle Change 0.60 → 0.40mm

Removed the 0.60 nozzle and installed the new Amazon-purchased 0.40mm E3D nozzle.

- Then loaded nGen.
- Then started to print the Calibration Cube and realized I needed to do First Layer Calibration (the nozzle was looking extremely close to the PEI sheet!)
- Began Calibration => First Layer Cal. and it called for PLA to be loaded, rather than nGen. Aborted and then …
- Unloaded nGen and loaded Rigid.ink Red PLA.
- Did Calibration => First Layer Cal. And the live Z-height was still good at -0.725mm.
- Re-loaded nGen.

5/10/2018 Print of XYZ20mmCalibrationCube in nGen



XYZ20mmCalibrationCube using nGen.

- Printed: May 10, 2018
- Source: https://www.thingiverse.com/thing:2790787
- STL: `xyzCalibration_cube.stl` (7 KB)
- Factory: `XYZ20Cube_20180510_S3D_Pi3Mk3_nGen_Infill30.factory`
- Profile: `Pi3Mk3_BF_CG_nGen_Infill30.fff`
- Based on: `Pi3Mk3_BF_CG_nGen.fff / PLA / High` (see above)
- G-code: `XYZ20Cube_20180510_S3D_Pi3Mk3_nGen_Infill30.gcode` (457 KB)
- Slicer: Simplify3D 4.0.1. Profile modifications:
  - Infill: Infill 30%
- Printer: Pi3Mk3/CG, 0.40mm brass E3D nozzle

- **Bed Prep:** IPA 91% one wipe. Kores glue stick cold, smoothed with plastic putty knife. Preheat to 60°C, gentle wipe with paper towel.
- **Filament:** ColorFabb nGen Clear 1.75m
- **Predic build time:** 0h 53m, Fil. length: 1.848 m, Plastic weight: 5.56g (0.01 lb), Cost 0.25
- **Actual build time:** 0h 58m
- **Printed part marked:** *"9"*

Results: ***Excellent!*** The most important thing is that the glue stick worked and the print did not rip the PEI off the Prusa Spring Steel Sheet. On close examination, there are a few issues that can be seen:

- There is evidence of a bit of "Elephant feet" at the bottom layer perimeter of the print.
- There was some (a bit) of warping in all 4 corners of the bottom of the print.
- There is a change in texture about ¼ of the way up the print.
- There is some blobing and stringing on the top layer (the "Z" face of the print).

I attempted to fill in the "X" with crushed red Ocre from Burminco's using regular Titebond. It held the filling in place, but smeared unacceptably over the surface.

I attempted to fill in the "Y" with crushed blue Lapis from Burminco's using CA glue. It was problematic to apply cleanly, picked up lots of bits of the filling, and about half the filling was not secured and fell out.

Breath Flute #75 – Improvements Beginning 5/10/2018

The issues addressed in this version …

- Need to initiate a document – or a video? – for fabricators producing Breath Flute renderings. *DONE – 5/13/2018 – started the BreathFlute_DevelGuide.docx and re-organized how public documents are distributed, in the /DocPub directory.*

  Topics:
  - Font usage (Kurinto) and why;
  - Z axis issues with the layer height and FHt;
  - slicing issues in general – angles for infill.
  - Fabricator codes
  - Complexity of the Lip and how to address it. Need for a hefty machine.
  - The names of all the parts ("Crown", "Platform", "Bird Peg", "Body-Dist Peg", Flare, Throat, Lip).
  - A tour of each of the parts.
  - Need for brims.
- What if we set it up so that the start-end points were inside the inlay channel! i.e. underneath the inlay!! ***TBD***
- Affix the `Bird` to the `BodyProx` with Fastenal set screws! *DONE – 5/11/2018.*
- May need a custom Brim for the `Bird` component, specifically to not attach the brim on the underside of the flue exit (where it would interfere with the chamfer), but attach it on all other quadrants, including the underside on the sides, where they can be filed off flat. ***TBD***
- Change the location of the "Breath Flute" imprint on the front of the BD component below the TSH. Place "Bre" and "Fl" on the vertical part of the body, and continue with "ath" and "ute" on the flange. This will allow it to be straight? Or maybe keep it angled? And to be larger. *DONE – 5/11/2018.*
- Alcohol testing on the nGen cube. ***TBD***
- Consider providing a raised plate ("platform", "dais"?) for the "Breath Flute" inscription on the `BodyDist` component. The platform would facilitate filling-and-sanding (Woodfill? Sculpt Wood? Engraving Filler Stick / Putty?) The platform could both raise at the edges and cut into the circumference of the `Headjoint`. Four separate platforms, two on the TSH cylinder area and two on the Flare. ***TBD***
- Locate engraver's filler to fill in the Breath Flute logo – Stew Maclen Laskin engraving filler? Bowling Ball engraver filler? Markforged Engraver Filler labelling article? ***TBD***
- Consider printing the logo in Reverse in a different color and snapping it in. Is this feasible?? Too finicky?? ***TBD***
- Add a `needLip` parameter on the main body-build routine – a By-Name parameter that can be turned off (`false`) for components that do not need the expensive-to-render Lip (like the `Bird`, `BodyDist`, `Foot`, etc.). *DONE – 5/11/2018. Before the needLip parameter, a render of all components took 5h 43m. After needLip was implemented for BodyDist, Bird, and Foot, a render-all took 4h 16m!*

- Address the need for hand-editing the OpenSCAD code for a change in the number of characters in the version number (the `rampVersionX` variable). *DONE – 5/12/2018 – using a conditional expression.*
- Investigate fonts specifically for use with the Breath Flute … a fixed-pitch font for things like version numbers (that are currently subject to variability in positioning because the width of digits varies). Also, match the Breath Flute logo on the model to the one used in the logo? ***TBD***
- Need to add a CC declaration on all public documents. ***TBD***
- A Bing search of "paint inset lettering 3d print" produced some resources for highlighting the "Breath Flute" logo on the front of the flute (see `FillingInsetLettering.docx`):
  - Markforged article using "engraver filler" (aka "engraving filler") - https://markforged.com/blog/engraver-filler-labeling/
  - Laskin's Engraving Filler – at StewMac: http://www.stewmac.com/Luthier_Tools/Tools_by_Job/Tools_for_Inlay_and_Pearl_Cutting/Laskins_Engraving_Filler.html
  - Bowling Ball Engraving Filler Lacquer Sticks: https://www.bowlerx.com/Bowling-Ball-Engraving-Filler-Lacquer-Sticks-INNLACQUER.htm
- Change `RenderMode` to `RenderDetail` and change the values from "Preview" and "Print" to "Coarse" (the old Preview), "Medium", and "Fine" (the old Print). This simplifies / regularizes settings to some degree (they now line up with the "c" and "f" indicators in the `.stl` file names) and adds a new middle-ground setting for higher-quality live `F6` rendering. *DONE – 5/19-20/2018.*
- Handle updated versions of David Eccles's `path_extrude.scad` module posted on GitHub, and deal with the licensing of that module. ***TBD***
- Develop release scripts. *DONE – 5/18/2018 – developed using a stripped-down version of the Flutopedia release perl scripts.*
- Implement a new `Lip` component – which just prints the `Lip` portion of the `BodyProx` component. *DONE – 5/19/2018.*
- Re-locate the `/BF_Model` directory to `/Src`. *DONE – 5/21/2018*
- Introduce a new "SuperFine" ("s") setting for `RenderDetail`. This should affect only the rendering of the Lip component – leave "SuperFine" for the current (needlessly high) `$fn` settings for `Lip` and change "Fine" to one level down (half of SuperFine?). *DONE – 5/21/2018*
- Break up the `BreathFluteLib.scad` module into `Conversions.scad`, `Wedges.scad`, and `Constants.scad` – to better compartmentalize and also deal better with contributed software. *DONE – 5/24/2018*
- Change the Nathanaël Jourdane `StringToNumber()` code from a stand-alone comment on the OpenSCAD project to the Zazouck module. This solves the licensing issue (Zazouk is GPLv3). *DONE – 5/24/2018*

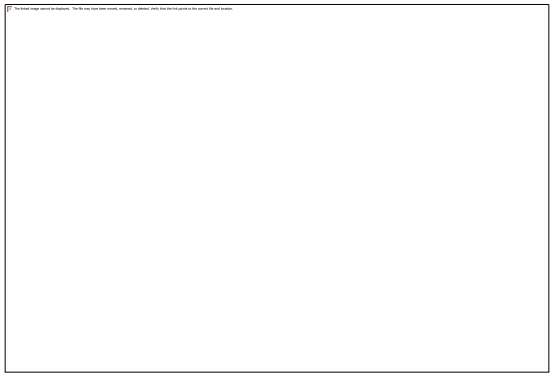
Extensive work with David Eccles' path_extrude.scad module

Significant work done 5/16–20/2018 on the `path_extrude.scad` code of David Eccles ("gringer" on GitHub and Thingiverse).

Background

The initial work with `path_extrude.scad` was done 2/9/2017 during v40 development to implement the Lip portion at the proximal end of the `BodyProx` component. Then-current versions of `path_extrude.scad` were fetched from Thingiverse (CC-BY-SA-3.0) and then GitHub (no license in evidence). Initial work had problems during F6 render with a CGAL assertion, but this was averted by splitting the path into two overlapping halves and joining the results of `path_extrude()` on each half.

The downloaded GitHub file was modified by Clint and included as `PathExtrude.scad` into the main Breath Flute OpenSCAD model. However, there was only cursory modifications to the code and the addition of identifying comments.



This code was used from v40 through v74 and performed well, albeit with substantial complexity to the model. The image at the right shows a rendering of the v67 `BodyProx` component with the Lip.

Licensing

In preparation for an eventual release, I contacted David Eccles on 5/16/2018 about the status of the code. He indicated his intent that the entire `bioinfscripts` package on GitHub be released under GPLv3 and added a GPLv3 `LICENSE` file to that project a few hours later.

He also indicated that there were later versions of `path_extrude.scad`.

Development

Beginning 5/17/2018, I made numerous updates in relation to the `path_extrude.scad` module:

- Retrieved all nine versions of `path_extrude.scad` that I could find on Thingiverse and GitHub. These are saved and logged in `/ThirdParty_Models/PathExtrude_DavidEccles`.
- Changed the reference to `path_extrude.scad` from an OpenSCAD `include <>` to an OpenSCAD `use <>`. This allows inclusion of the module without the need to delete the demo / test code in the source file.
- Relocated the module from the top-level source directory to the `/Bioinfscripts` subdirectory. This allows for inclusion of files specific to this module (the `LICENSE` file for that component, as well as a `ReadMe.txt` file describing the context).
- Updated the License statement to include David Eccles' copyright, where appropriate.
- Tested each of the versions in the Breath Flute model, using the `Lip` component and a `RenderDetail` setting of "Medium". Tested both F5 and F6 renderings. The results of this testing are below. The code for testing is preserved in the backup file

`BFlute_075_Bak20180520f_FinalBeforeDeletingPathExtrudeExperimentationCode.scad`, but was subsequently deleted, since we're going forward with a single version of the `path_extrude()` code.

Testing

This section preserves the results of testing the various versions of the `path_extrude.scad` module. The sections are in order of the date that the version was checked in to GitHub or Thingiverse.

Note that there the signature (calling sequence) of `path_extrude()` changed between 2016 and 2018 from:

```
path_extrude (points, path, pos = 0, merge = false, extruded = [])
```

to:

```
path_extrude (exPath = myPath, exShape = myPoints, exRots = [0], merge = false)
```

This is handled in the testing code by setting the `PathExtrudeCallFormat` variable to 2016 or 2018 as appropriate.

Thingiverse 11/19/2013

11/19/2013 is the date listed as the initial post date on http://www.thingiverse.com/thing:186660. However, there is no "previous version" facility on Thingiverse, so I have no access to this version. The earliest version I have is the Thingiverse version I retrieved on 2/9/2017 (below).

GitHub 1/5/2016 (A)

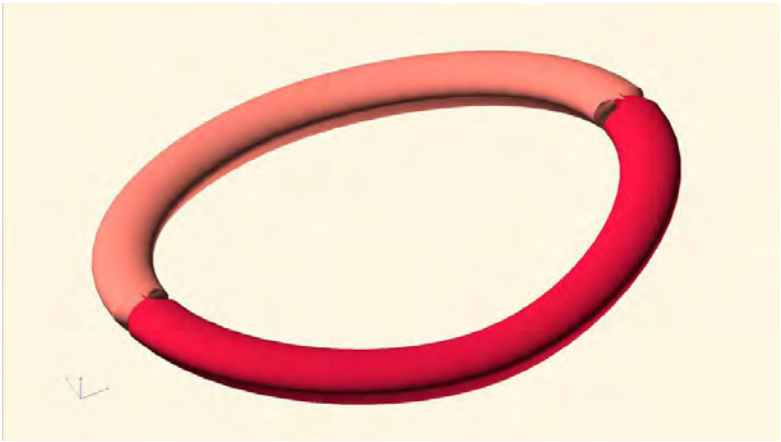
The earliest known version of the code – the first version checked in to GitHub.

```
PathExtrudeCallFormat = 2016;
//include <Bioinfscripts/path_extrude_20160105a_GitHub_WIN.scad>;
use <Bioinfscripts/path_extrude_20160105a_GitHub_WIN.scad>;
```

`Include <>` works with F5 and F6 (with the demo objects at the bottom).

`Use <>` works with F5 and F6.

HOWEVER, the ends of each of the two paths that make up the lip are mal-formed, and there is a pile of ECHO output on the console.



```
F6 (Include): PolySet has nonplanar faces. Attempting alternate construction
(2x)
F6 (Include) render time: 20 seconds (Component = Lip; RenderDetail = Medium)
F6 (Include) WARNING: Object may not be a valid 2-manifold and may need repair!
F6 (Use): PolySet has nonplanar faces. Attempting alternate construction (2x)
F6 (Use) render time: 18 seconds (Component = Lip; RenderDetail = Medium)
F6 (Use) WARNING: Object may not be a valid 2-manifold and may need repair!
```

GitHub 1/5/2016 (B)

A later check-in the same day on GitHub. This version matches what we have been using from v40 through v74 (based on path_extrude.scad retrieved from GitHub on 2/9/2017).

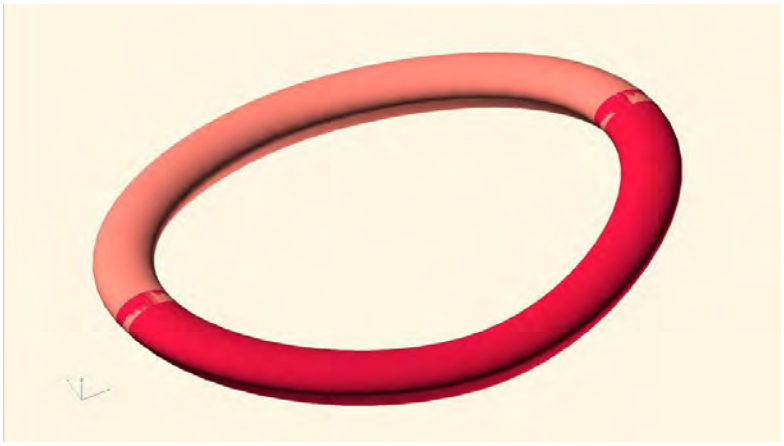
> *This is the selected version of* `path_extrude.scad` *and the one we will be using going forward.*

```
PathExtrudeCallFormat = 2016;
//include <Bioinfscripts/path_extrude_20160105b_GitHub_WIN.scad>;
use <Bioinfscripts/path_extrude_20160105b_GitHub_WIN.scad>;
```

`Include <>` works with F5 and F6 (with the demo objects at the bottom).

`Use <>` works with F5 and F6.

Rendering appears identical to the CGMod code used from v40 through v74 (based on path_extrude.scad retrieved from GitHub on 2/9/2017). Notice the subtle cross-over where the two extruded paths intersect:



```
F6 (Include): PolySet has nonplanar faces. Attempting alternate construction
(4x)
F6 (Include) render time: 23 seconds (Component = Lip; RenderDetail = Medium)
F6 (Use): PolySet has nonplanar faces. Attempting alternate construction (2x)
F6 (Use) render time: 19 seconds (Component = Lip; RenderDetail = Medium)
```

GitHub and Thingiverse versions fetch 2/9/2018

These are the files I fetched initially.

```
PathExtrudeCallFormat = 2016;
use <Bioinfscripts/path_extrude_20170209a_ThingiverseFetch_WIN.scad>;
   … and …
PathExtrudeCallFormat = 2016;
use <Bioinfscripts/path_extrude_20170209b_GitHubFetch_WIN.scad>;
```

`Use <>` works with F5 and F6.

Rendering for both these versions appears identical to ***GitHub 1/5/2016 (B)*** (above). They also report identical results in the Console window:

```
F6: PolySet has nonplanar faces. Attempting alternate construction (2x)
F6 render time: 19 seconds (Component = Lip; RenderDetail = Medium)
```

Thingiverse 2/22/2018 (v1)

A version fetched on 5/19/2018 from Thingiverse. The download package has three versions of `path_extrude.scad`. The date for this version is the date shown by Thingiverse as "last updated".

```
PathExtrudeCallFormat = 2016;
use <Bioinfscripts/path_extrude_20180222_Thingiverse_v1_WIN.scad>;
```

`Use <>` works with F5 and F6.

Rendering for both these versions appears identical to ***GitHub 1/5/2016 (B)*** (above).

```
F6: PolySet has nonplanar faces. Attempting alternate construction (2x)
F6 render time: 19 seconds (Component = Lip; RenderDetail = Medium)
```

Thingiverse 2/22/2018 (v2)

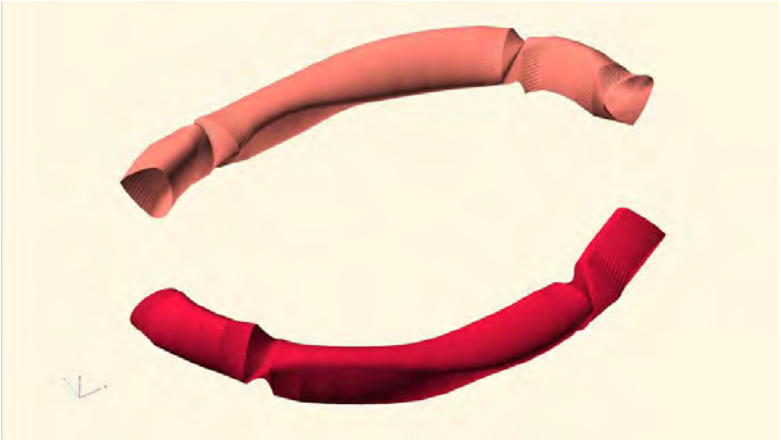
A version fetched on 5/19/2018 from Thingiverse. The download package has three versions of `path_extrude.scad`. The date for this version is the date shown by Thingiverse as "last updated".

This is the first version to use the 2018 calling sequence:

```
PathExtrudeCallFormat = 2018;
use <Bioinfscripts/path_extrude_20180222_Thingiverse_v2_WIN.scad>;
```

`Use <>` works with F5 and F6.

HOWEVER, the rendering is completely twisted and messed up!



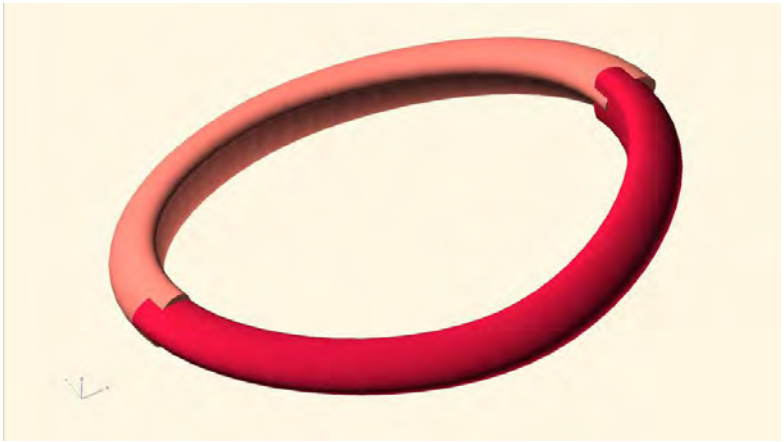
```
F5: WARNING: PolySet has degenerate polygons
F6: ERROR: Unable to convert point at index 2 to a vec3 of numbers
F6 WARNING: Object may not be a valid 2-manifold and may need repair!
F6 render time: 11 seconds (Component = Lip; RenderDetail = Medium)
```

GitHub 3/7/2018

A GitHub version checked in on 3/7/2018.

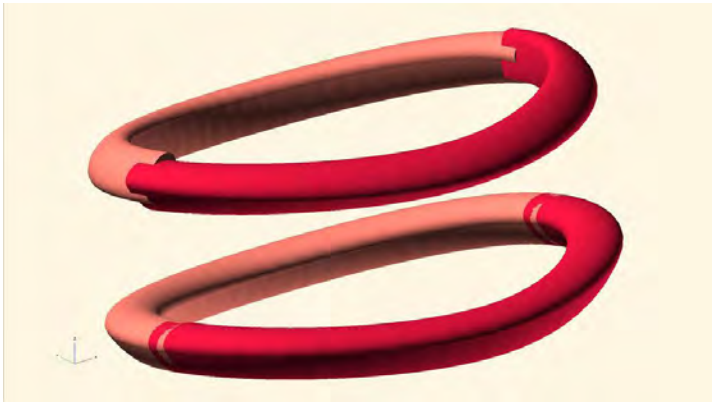
```
PathExtrudeCallFormat = 2018;
use <Bioinfscripts/path_extrude_20180307_GitHub_WIN.scad>;
```

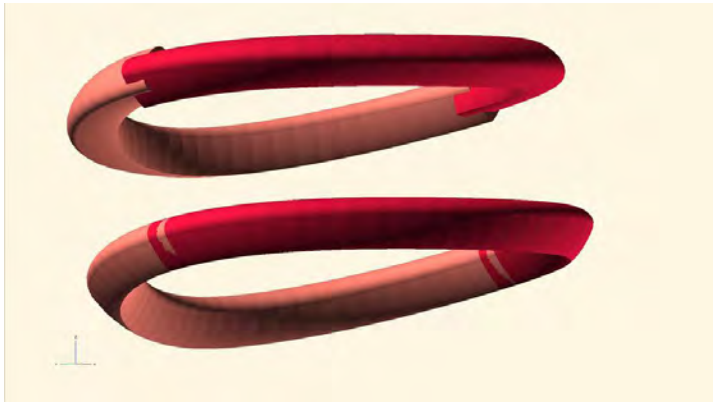
`Use <>` works with F5, but F6 ***blows up.*** The F5 rendering is odd, with the ends of the two paths out of line:



```
F6 CGAL: ERROR: Alternate construction failed. CGAL error in
CGAL_Nef_polyhedron3(): CGAL ERROR: assertion violation! Expr: e-
>incident_sface() != SFace_const_handle() File: /opt/mxe/usr/x86_64-w64-
mingw32.static/include/CGAL/Nef_S2/SM_const_decorator.h Line: 326
```

Here are two more images from above and below showing this GitHub 3/7/2018 version on the top and the GitHub 1/5/2016 (B) version below. You can see the different renderings of the shape of the lip on the bottom:





GitHub 3/12/2018

A GitHub version checked in on 3/12/2018.

```
PathExtrudeCallFormat = 2018;
use <Bioinfscripts/path_extrude_20180312_GitHub_WIN.scad>;
```

`Use <>` works with F5, but F6 ***blows up*** in the same way as ***GitHub 3/7/2018***. The F5 rendering is appears with the same odd, mismatched ends as in ***GitHub 3/7/2018***.

Thingiverse 3/13/2018

A version fetched on 5/19/2018 from Thingiverse. The download package has three versions of `path_extrude.scad`. This is the "main" version, without any `_v1` or `_v2` tags. The date for this version is the date shown by Thingiverse as "last updated".

```
PathExtrudeCallFormat = 2018;
use <Bioinfscripts/path_extrude_20180313_Thingiverse_primary_WIN.scad>;
```

`Use <>` works with F5, but F6 ***blows up*** in the same way as ***GitHub 3/7/2018***. The F5 rendering is appears with the same odd, mismatched ends as in ***GitHub 3/7/2018***.

Render History

Here is a log of recent executions of `render.bat`, with some statistics. The Number Comp column shows the number of components in that build:

Vers	Date Stamp	Number Comp	Render Time hh:mm	Notes
v072	2018 0416_1225	12	4:57	
v073	2018 0501_1415	13	4:41	
v074	2018 0505_1526	14	5:10	
v075	2018 0510_2017	23	5:09	Added renders for all 10 `SE` components
v075	2018 0511_1310	23	5:43	
v075	2018 0511_2106	23	*4:16*	Selective call to `lip()` using the `needLip` variable
v075	2018 0520_1348	24	4:26	Added the `Lip` (`LI`) component
v075	2018 0522_0105	24	*2:48*	Reduced `$fn` for `Lip` (new `RenderDetail` setting)
	The new `$fn` for the `Lip` component at v075 2018 0522_0105 reduced the total size for the 24 `.stl` files from 203 MB to 112 MB.			
v076	2018 0527_0831	24	2:57	
v076	2018 0527_1845	24	2:50	
v076	2018 0527_1845	28	3:22	Added renders for 4 more variants of `BodyProx`
v076	2018 0531_1034	29	3:20	Added renders the new `SandC` One `BodyProx` takes 21 minutes.
v077	2018 0608_1853	41	11:53	Lots of `BodyProx` – big slowdown – not sure why! Render of one `BodyProx` slowed from 21 to 33 min.
v077	2018 0609_1209	41	11:31	Rebooted machine. One `BodyProx` takes 31 minutes.
v077	2018 0611_1139	42	11:21	One `BodyProx` takes 29 minutes.
v077	2018 0612_2102	41	**13:51**	One `BodyProx` takes 38 minutes. It appears that the construction of `Nest()` is particularly expensive.
v077	2018 0613_1506	41	8:16	One `BodyProx` takes 27 minutes. Speedup from boxing off the Nest area.
v077	2018 0616_1204	45	8:25	One `BodyProx` takes 27 minutes.
v077	2018 0617_0634	45	8:25	One `BodyProx` takes 27 minutes.
v078	2018 0622_1426	50	7*:56*	One `BodyProx` takes 23 minutes! Implemented changes to elim CGAL Nonplanar Faces errors (didn't work). Also many `$fn` adjustments.
v078	2018 0623_0805	52	8*:00*	`BodyProx`: 23 min.
v078	2018 0624_1515	68	10:47	`BodyProx`: 23 min. Many new size variants on `Sand*`.
v078	2018 0628_1804	71	11:06	`BodyProx`: 24 min. Changed how Body is sliced.

v078	2018 0701_1600	84	14:26		BodyProx: 25 min. Rework render.bat for full generation of all STL files for the distribution package.
v078	2018 0702_0931	8	1:39	Dev	BodyProx: 22 min. New Dev mode for render.bat.
v078	2018 0702_1341	84	14:12	All	BodyProx: 21 min.
v078	2018 0703_1303	88	16:19	All	BodyProx: 22 min.

Lip Rendering

Here is a log of the complexity of the Lip component and the time for an F6 render:

Detail	Vertices	Edges	Facets	Render m:ss	Notes
Coarse	740	1,562	822	0:02	
Medium (A)	4,922	12,788	7,866	0:20	(A) Pre-5/21 updates for SuperFine
Medium (B)	6,722	18,068	11,346	0:28	(B) Post-5/21 updates for SuperFine
Fine	18,218	51,644	33,426	1:36	New settings for Lip
SuperFine	68,778	200,390	131,612	8:32	Fine setting pre-5/21, now SuperFine setting post-5/21

BuildTak FlexPlate and Print Surface vs. the Prusa SSS and PEI Sheet

Ordered Mk3-sized FlexPlate (their spring steel sheet) plus a BuildTak Print Surface (not PEI – the BuildTak Print Surface is own formula for printbed surface adhesion). Ordered 5/12/2017, received 5/17 USPS. The FlexPlate is stanped "BTP34996".

On 5/28/2018, on advice from the Prusa Forum, I ground down the edges. There are issues with burrs – ones you might not even be able to feel – ripping tears in the of Prusa print beds. I used the smoother (right) side of the Walter Shanov grinding wheel – rounding the edges as best as I could. I then hand-ground the edge in general with a grinding stone. Then boxed both items (the FlexPlate and Print Surface) for potential future use.

Build Plate Thicknesses

Info on thickness of various products:

- The Thekkiinngg brand "Prusa i3 Mk3 Mk2.5 Double-sided Pei TEXTURED Powder-Coated spring steel sheet" available on EBay at https://www.ebay.com/itm/332649969907 ($59.99) and Amazon at https://www.amazon.com/gp/product/B07CXV5W2W ($59.99 + $15 shipping) was reported by Prusa Forum user john.v11 as 0.58–0.60 mm thick (https://shop.prusa3d.com/forum/general-discussion-announcements-and-releases-f61/steel-build-plates-a-rant--t15441-s50.html). That would include the powder coating on the spring steel sheet.
- The Prusa SSS with PEI sheet on both sides I measured earlier at 1.11–1.14 mm thick.
- The Original Prusa (?Ultem?) PEI sheet is 7 mil (0.007″ = 178 µm, 0.178 mm) (from Pursa forum user carl.k – https://shop.prusa3d.com/forum/hardware-firmware-and-software-help-f80/ultem-pei-bed-film-replacement-t1086-s20.html) (also quoted as 175 µm by Thomas Sanladerer at 3:15 in the YouTube video *Guide: Restoring and maintaining a PEI printbed!* – https://www.youtube.com/watch?v=DzaPFlEKP10)

- Other available Ultem® PEI sheet thicknesses from CS Hyde: 31 mil (0.031″ = 787 µm, 0.787 mm), 10 mil (0.010″ = 254 µm, 0.254 mm), 5 mil (0.005″ = 127 µm, 0.127 mm) (users avi.s, jay.b, and cark.k … same link as above).
- The thickness of other Ultem PEI + 3M™ Acrylic Adhesive products from CS Hyde (https://catalog.cshyde.com/category/pei-ultem). All PEI sheets have a Matte finish on one side and a Gloss on the other side – the acrylic adhesive can be applied to either side:
  - 3 mil + 2 mil = 5 mil (0.005″ = 127 µm, 0.127 mm)
  - 5 mil + 5 mil = 10 mil (0.010″ = 254 µm, 0.254 mm)
  - 10 mil + 5 mil = 15 mil (0.015″ = 381 µm, 0.381 mm)
  - 20 mil + 5 mil = 25 mil (0.025″ = 635 µm, 0.635 mm)
  - 30 mil + 5 mil = 35 mil (0.035″ = 889 µm, 0.889 mm)
  - 40 mil + 5 mil = 45 mil (0.045″ = 1,143 µm, 1.143 mm) – Gloss both sides of PEI
- Based on this info, the Prusa SSS without any adhesives surfaces would be about 1.12 – (0.178 × 2) = 0.76 mm … substantially thicker than the BuildTak FlexPlate.
- Measuring the FlexPlate and BuildTak surface I received:

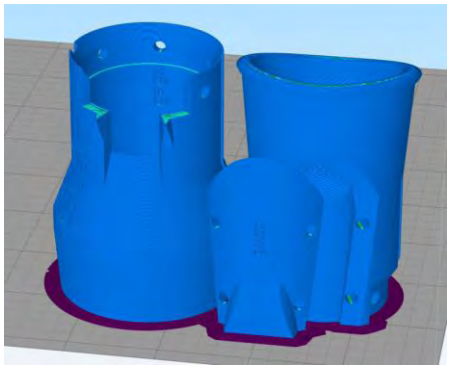
FlexPlate	BuildTak Surface (***with*** adhesive backing)	
0.53 mm	0.43 mm	Back Center (between the two V-shaped notches)
0.53 mm	0.44 mm	Center Right
0.52 mm	0.44 mm	Front Right
0.53 mm	0.42 mm	Front Center
0.53 mm	0.43 mm	Front Left
0.51 mm	0.43 mm	Center Left

- The adhesive backing on the BuildTak Print Surface measures 0.05 mm (by peeling up one corner slightly and measuring just that corner). This means the BuildTak surface should add about 0.43 – 0.05 = 0.38 mm to the FlexPlate.
- From Kevin Wadsworth of BuildTak by email 5/23/2018: *"the thickness of a BuildTak PEI sheet is the same as that of a BuildTak Original sheet."* and *"the adhesive [for the BuildTak PEI sheet] is the same as for BuildTak Original"*.
- With two BuildTak Print Surfaces, I would get a thickness of 0.52 + (0.38 × 2) = 1.28 mm thick (vs. the 1.12 mm thick Prusa SSS with PEI sheets). However, the 0.38 mm BuildTak Print Surface is 0.2 mm thicker than then Prusa standard 7 mil PEI sheet (0.18 mm).
- PINDA Lift on my printer … measured 4/2/2018: The PINDA works out to 0.82mm above the tip of the extruder nozzle. I used paper feeler gauges made of 24lb Staples printer paper. On-line sources quote 24lb Bond at 0.004″ = 0.01016 cm = 0.1016 mm per sheet. Cleaned the nozzle (Raise Z, Unload Filament, Heat, Cleaned with brass brush) and then did Calibration → Auto Home with NO SSS installed. Height of Nozzle: 5 paper sheets (a bit tight) = 0.50mm. Height of PINDA: 13 paper sheets (nicely snug) = 1.33 mm (or 0.1023 mm per sheet). Difference: 8 paper sheets or 0.82mm

- Prusa recommends a ziptie for setting the PINDA Lift (Prusa i3 Mk3 Assembly Manual, Chapter 9, Step 3 – https://manual.prusa3d.com/Guide/9.+Preflight+check/514). The thickness of a ziptie is 1.18 mm from Prusa forum user john.n13 (https://shop.prusa3d.com/forum/general-discussion-announcements-and-releases-f61/pinda-sensor-placement-t15688.html). A comment from the manual by Gerry P (April 6, 2018) states that *"The zip tie is about 1.2mm thick. For me to pass calibration (next step), I need to lower the PINDA probe to about 0.65mm (by using 9 sheets of paper) …"*.

- Recommended height of PINDA probe above the nozzle tip:
  - *"2mm works for me … Higher clearance of probe above printed object gives advantage of less risk of colision in case of printing problems (raised corners for example)"* – Prusa forum user david.t2 – https://shop.prusa3d.com/forum/others-archive--f82/pinda-probe-height-in-relation-to-extruder-nozzle-t1007.html
  - *"about 1mm worked for me!!"* – user todd.m2 – same link as previous bullet
  - *"The PINDA sensor is exactly one ziptie (middle of it) away from the bed when the nozzle touches the bed."* Chris3030 – Apr 15, 2018 7:54 am – https://shop.prusa3d.com/forum/general-discussion-announcements-and-releases-f61/pinda-sensor-placement-t15688.html#p86845 – Clint: *"Could some possibly convert "One ziptie (middle of it)" into mm? (or microns, yards, furlongs, light years ...)"*

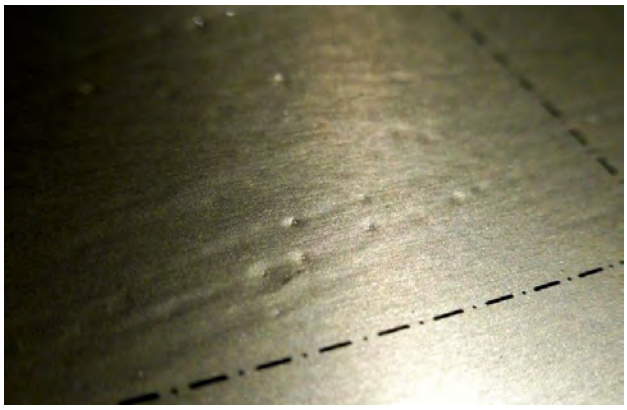
5/24/2018 Print of current BP/BD/BI v75 components in nGen



Three main components using nGen.

- Printed: May 24, 2018
- Source: `BFlute_075.scad`
- STL:
  `BFlute_075_BI_CG_f125_20180522_0105.stl` (2.7 MB)
  `BFlute_075_BP_CG_f125i3_20180522_0105.stl` (18.0 MB)
  `BFlute_075_BD_CG_f125i3z5e5_20180522_0105.stl` (7.5 MB)
- Factory: `BFlute_075_Z1_CG_f125_20180522_0105.factory`
- Profile: `Pi3Mk3_BF_CG_nGen_Brim.fff`
- Based on: `Pi3Mk3_BF_CG_nGen.fff / PLA / High` (see above)
- G-code: `BFlute_075_Z1_CG_f125_20180522_0105.gcode` (47.2 MB)

- **Slicer:** Simplify3D 4.0.1. Profile modifications:
  - **Additions:** SkOffset 0, SkOutlines 10
- **Printer:** Pi3Mk3/CG, 0.40 mm brass E3D nozzle
- **Bed Prep:** Cold Prusa PEI SSS. IPA 91% moderate rub. Magigoo even, thin layer. Note that the Magigoo leaves bubbles on the surface (pic at right).
- **Filament:** ColorFabb nGen Clear 1.75m
- **VidSetup:** *(none)*
- **Video:** *(none)*
- **Predic build time:** 11h 50m, Fil. length: 32.430 m, Plastic weight: 97.50g (0.22 lb), Cost 4.49
- **Live Tuning:** *(none)*
- **Actual build time:** Print failed at 1h 48m
- **Printed part marked:** *(not marked)*



Results: Print Failed – slid off the print bed. Examining the underside, it appears that the bond between the PEI surface and the layer of Magigoo did not hold. The Magigoo seened well-stuck to the nGen first layer.

5/24/2018 Second Print of current BP/BD/BI v75 components in nGen

Exactly the same setup as the prior print except:

- **Bed Prep:** Clean the bed with water. One wipe with IPA. Then apply Windex® Original (clear blue fluid in spray bottle) to a dry paper towel and apply. Let dry.
- **Predic build time:** 11h 50m, Fil. length: 32.430 m, Plastic weight: 97.50g (0.22 lb), Cost 4.49

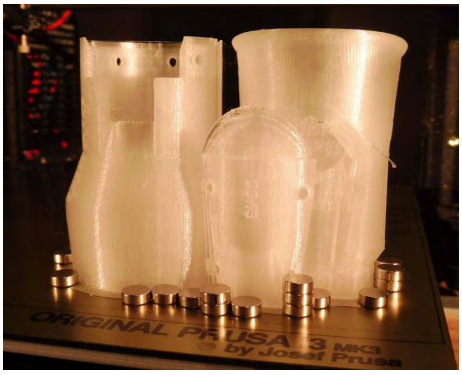
- **Live Tuning:** Realized that I could put magnets on the brim after a certain Z-height. Paused the print and added about 7 magnets when at the appropriate height:

Then, at 38.75 mm Z-height (about 8h 30m into the print) I heard some banging and realized that the extruder was banging into the print, that had lifted off the bed on the right side. Paused the print again and added a lot more magnets – maybe 25 in total. Some of them were stacked 2 or 3 high (because they "grabbed on" while I was positioning them). I realized that I could place a magnet just barely on the brim and slide it close to the printed part.

Rare earth magnets seem to work in either side on the Prusa bed. Also realized that the `Bird` component is quite wobbly. I'm thinking that it has become detached from its brim. Maybe print brims 2-layers high next time?

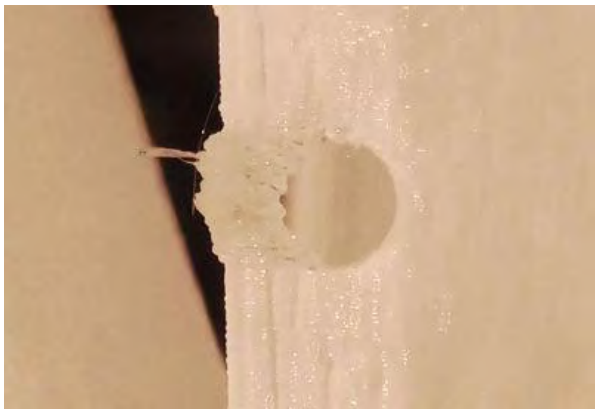
- **Actual build time:** Print 13h 56m
- **Printed part marked:** *(not marked)*

Results: Print finished, with notable damage from the partial disconnect from the print bed at 38.75 mm Z-height during the print.



You can also see the strings where the print was stopped twice.

The new peg holes in the `Bird` did not print well. They are too close to the outer wall and the "stacking" of the very narrow towers on the outer edges of the `Bird` near the peg holes is ugly:



5/25/2018 Prusa forum post

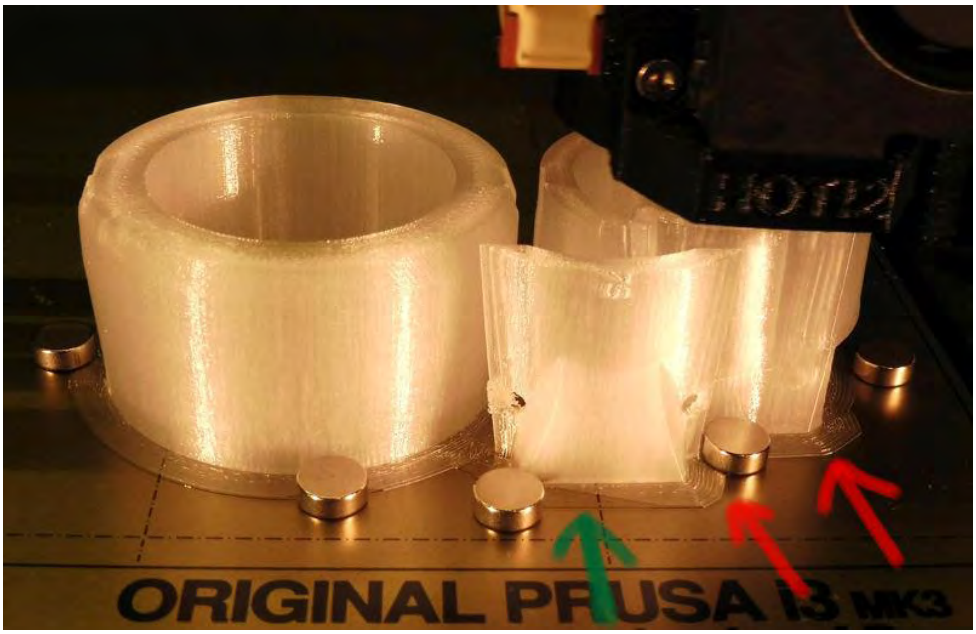
Subject: Magnets on the Print Bed

It's been air-print hell for the last few days. Moved from PLA to nGen, which has more shrinkage issues. Also, the specter of a strong grip on the print bed destroying my unobtanium PEI Spring Steel Sheet.

To avoid disaster, I've used Magigoo first (two failures), then Windex Original liquid spray (one failure) on my 14-hour print.

All prints have *"slipped the surly bonds of the PEI bed and taken flight"* after an hour or two, leaving the extruder to do its Air Print Parody Dance.

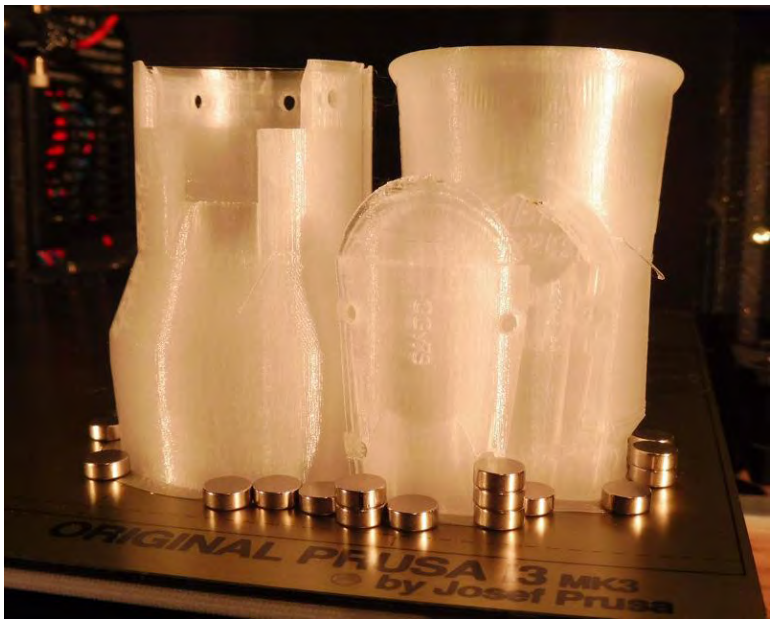
On print #4, I hit on an idea: **Magnets**. I've got a pile of spare 8 mm × 3 mm rare earth magnets left over from the rotation visualizer project. My print has a 10-perimeter, one-layer brim, so I pause the print and add a few magnets to the brim. Seems nice and secure.



However, notice the green arrow, where the brim is visibly stuck to the bed (darker color on the brim), versus the red arrows where the brim seems to have separated (lighter color).

Fast forward 8 hours … the extruder starts banging into the print … one side has lifted off and two of the magnets are off the brim. I strike back with a barrage of 20 more magnets. Some grab onto others and stack themselves up two or three-high. *No problem!*

Print finished, with some damage during the banging phase. This is beginning to seem like a viable technique (although I'm sure it will be laughable in 30 years, when we have turn-key, sub-second fabrication).



I'm now surfing for appropriately sized Rare Earth magnets. Round ones are available in thicknesses of 3mm (0.12″), 1.5mm (0.06″) and 1/32″ (0.8mm).

Has anyone else gone down this road?? *Any thoughts, ideas, advice would be welcome!!*

Rare Earth Magnets:

Potential sources for Rare Earth (Neodymium) magnets that could be used to nail down the print bed:

- 50pcs N35 Round Magnet 8 × 3 mm (0.3 × 0.12″) Disc Rare Earth Neodymium New – $7.59 – Purchased 3/3/2018 https://www.ebay.com/itm/232371427534.
- 1/16″ × 1/32″ tiny Neodymium Rare Earth Disc Magnets N48 (500 Pack) – $11.99 https://totalelement.com/products/1-16-x-1-32-inch-neodymium-rare-earth-disc-magnets-n48-500-pack
- Strong Neodymium Disc Magnets (12 Pack) - Powerful, Small, Round, Rare Earth Magnets - N45 Industrial Strength NdFeB Magnet Set for Fridge, DIY, Crafts - 1.26″ × 0.08″ – $13.95 https://www.amazon.com/gp/product/B0718Y92S5

Breath Flute #76 – Improvements Beginning 5/25/2018

The issues addressed in this version …

- Straighten out the handling of various flavors of Text files. Currently we're maintaining parallel versions of some text files for Unix (LF) and DOS (CR+LF). Could also have the old (pre-OS X) standard of OLDMAC (CR). Doing this because some applications (e.g. Notepad) do not deal well with Unix format text files. Note that the Unix convention is to terminate the last line with a LF, while the last line for DOS text files does not have a line terminator.
  File names currently are `NAME` and `NAME.txt`, which creates heartburn because (a) two files need to be maintained, (b) the `NAME` file has no extension, causing issues, (c) it is not clear which is the original / master and they could get out of step, and (d) all upper-case letters are somewhat visually offensive.
  The new strategy:
  - All text files are in one version, with `Name.txt` as the naming convention and using DOS (CR+LF).
  - `ReadMe.txt` at the top level and `BreathFlute_DevelGuide.docx` need to say that (a) files from some source distributions have been renamed to add the `.txt` file extension and (b) all files have been converted to the DOS convention (CR+LF), but augmented so that the last line is terminated by a CR+LF.

  DONE – 5/26/2018

- Complete the work with all the third-party code that we use. This involves `HowTo.txt`, changes to `Authors.txt`, `gen_release.pl`, etc. *DONE – 5/28/2018*
- Address issues with the peg holes on the `Bird`. They do not print well on the bird. Maybe try canting them significantly so that they orient more along the outer edge of the `BodyProx` component. This would allow the peg holes to be open on the sides (like the one peg hole in the "back" of the BodyProxHalf component) and allow the peg holes to act as an inward-canted wedge, holding the `Bird` in place. *DONE – 5/27/2018*
- Add a new middle Bird peg hole for strength. *DONE – 5/27/2018*
- Add a box to the back of the Bird Peg holes to provide support for all the cylinders around the peg holes – otherwise they are hanging in space. *DONE – 5/27/2018*
- Fix the top and middle peg holes, which tend to go too deep. Render to STL and measure them in 3D tool. Can also make the Bird Peg Hole Box less deep. ***TBD***
- Specialized brims that accommodate magnets?? ***TBC (to be considered)***
- Overhaul the printing on the side of the headjoint and the inside of the `BodyDist` component. Current printing has gotten horrendously complex! It's been hacked, especially when the "Bre" "ath" and "Fl" "ute" were introduced in v75. Make it more like the printing of the peg cylinders for both the `BodyDist` and `Bird` components. *DONE – 5/26/2018*
- What if we set it up so that the start-end points were inside the inlay channel! i.e. underneath the inlay!! *TBD*

- May need a custom Brim for the `Bird` component, specifically to not attach the brim on the underside of the flue exit (where it would interfere with the chamfer), but attach it on all other quadrants, including the underside on the sides, where they can be filed off flat. This is problematic, because not attaching one side of the `Bird` to the brim is asking for it to fall over. ***TBD***
- Consider a sanding tool for the front lip of the bird – to restore the chamfer after removing the brim. ***TBC***
- Consider providing a raised plate ("platform", "dais"?) for the "Breath Flute" inscription on the `BodyDist` component. The platform would facilitate filling-and-sanding (Woodfill? Sculpt Wood? Engraving Filler Stick / Putty?) The platform could both raise at the edges and cut into the circumference of the `Headjoint`. Four separate platforms, two on the TSH cylinder area and two on the Flare. ***TBD***
- Locate engraver's filler to fill in the Breath Flute logo – Stew Maclen Laskin engraving filler? Bowling Ball engraver filler? Markforged Engraver Filler labelling article? ***TBD***
- Consider printing the logo in Reverse in a different color and snapping it in. Is this feasible?? Too finicky?? ***TBD***
- Investigate fonts specifically for use with the Breath Flute … a fixed-pitch font for things like version numbers (that are currently subject to variability in positioning because the width of digits varies). Also, match the Breath Flute logo on the model to the one used in the logo? ***TBD***
- A Bing search of "paint inset lettering 3d print" produced some resources for highlighting the "Breath Flute" logo on the front of the flute (see `FillingInsetLettering.docx`):
  - Markforged article using "engraver filler" (aka "engraving filler") - https://markforged.com/blog/engraver-filler-labeling/
  - Laskin's Engraving Filler – at StewMac: http://www.stewmac.com/Luthier_Tools/Tools_by_Job/Tools_for_Inlay_and_Pearl_Cutting/Laskins_Engraving_Filler.html
  - Bowling Ball Engraving Filler Lacquer Sticks: https://www.bowlerx.com/Bowling-Ball-Engraving-Filler-Lacquer-Sticks-INNLACQUER.htm

- Handle updated versions of David Eccles's `path_extrude.scad` module posted on GitHub, and deal with the licensing of that module. *DONE – 5/26/2018*
- Smooth out the transition from the ramp to the flue with an "eased" / curved transition. This involves the center curved section and the side straight sections. ***TBD***
- Move the top peg hole down a bit so that it does not cause a "bump" in the SAC area. ***TBD***
- Maybe use the new Bird Peg Back Box construction to widen the platform for the bird, making the bird wider and more robust. ***TBC***
- Add a parameter to select mouthpiece size – small, medium, large, and x-large. Current size should probably be large. Affects `BodyProx`, and `Bird`, since the crown angle will change for different shapes of SACs that correspond to different lip / mouthpiece sizes. *DONE – Sometime during the v76 development – not sure when.*

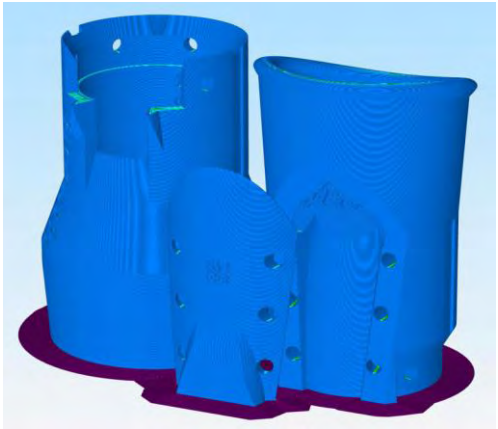
- Add Bolt Holes and Nut Slots to the bottom of `SandB` and `SandC` (and other components?) to allow them to be bolted down. ***TBD***
- Make the sides of the `SandN` component higher – even 220 grit sandpaper (Mercer Abrasives 200A) is thick enough to cause the sides to be very shallow and not so effective as guides. ***TBD***
- Beef up the top mortice in the BodyDist – it cracked in the first nGen Lux print. External beefy "blades" for strength? Or … maybe use *no* mortice and make the tenon in the BodyProx component smaller – which will change some of the longitudinal measurements. This will have the advantage of having one less diameter to ream / sand out … ***TBD***
- Need to include the SIL OFL license files with the font release! ***TBD***

5/27/2018 New Polymaker PolyBox

Purhcased and set up a Polymaker Polybox ($99 – Amazon) … to keep the active filament dry. Used one Eva-Dry E-333 (the "new and improved" with the larger, oval window) rather than the provided desiccant packs. Hygrometer reading fell from 47% to 18% within 6 hours.

Also added Eva-Dry units to the dry-boxes for filament storage.

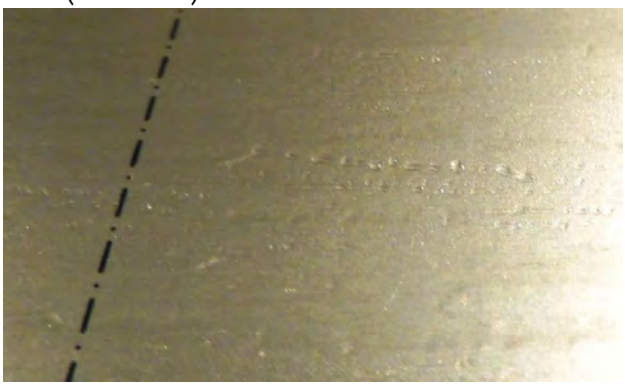
5/28/2018 Print of current BP/BD/BI v76 components in nGen



Three main components using nGen. Increased brim from 10 to 16 perimeters.

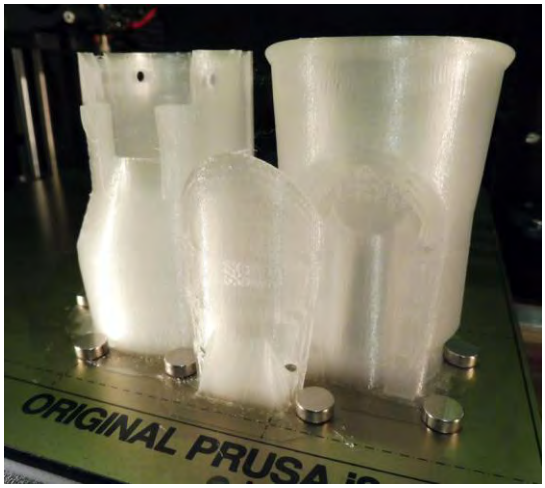
- Printed: May 28, 2018
- Source: `BFlute_076.scad`
- STL:
  `BFlute_076_BI_CG_f125_20180527_1845.stl` (3.8 MB)
  `BFlute_076_BP_CG_f125i3_20180527_1845.stl` (17.4 MB)

  `BFlute_076_BD_CG_f125i3z5e5_20180527_1845.stl` (7.6 MB)
- Factory: `BFlute_076_Z1_CG_f125_20180527_1845.factory`
- Profile: `Pi3Mk3_BF_CG_nGen_Brim16.fff`
- Based on: `Pi3Mk3_BF_CG_nGen_Brim.fff` (see above)
- G-code: `BFlute_076_Z1_CG_f125_20180527_1845.gcode` (46.3 MB)
- Slicer: Simplify3D 4.0.1. Profile modifications:
  - Additions: SkOffset 0, SkOutlines 16
- Printer: Pi3Mk3/CG, 0.40 mm brass E3D nozzle
- Bed Prep: Cold Prusa PEI SSS. Water – good scrub, Acetone – good scrub.
  Magigoo shake, invert 30 to let bubbles rise, lay down an even, thin layer. Note that the Magigoo bubbles and beads up



badly – differently on different parts of the
bed (pic at right). Smoothed out with a credit card while wet, but it now seems that the Magigoo coverage is not even, with noticable stripes of different shinyness. (pic below).

- **Filament:** ColorFabb nGen Clear 1.75m
- **VidSetup:** GoPro5 Black, Time-Lapse video, Res 1080, Intervals 10s, Zoom LINR (Linear)
- **Video:** `Video/BFlute_076_Z1_20180527_1845_GOPR0008.mp4`
- **Predic build time:** 12h 2m, Fil. length: 33.198 m,
  Plastic weight: 99.81g (0.22 lb), Cost 4.59
- **Live Tuning:** Paused printer and added 11 8×3 mm magnets at a reasonable Z-height.
  The print did not feel like it was lifting, but there was a noticeable brim area on the right that had the whitish look of being disconnected from the bed.
- **Actual build time:** 14h 11m
- **Printed part marked:** *(not marked)*

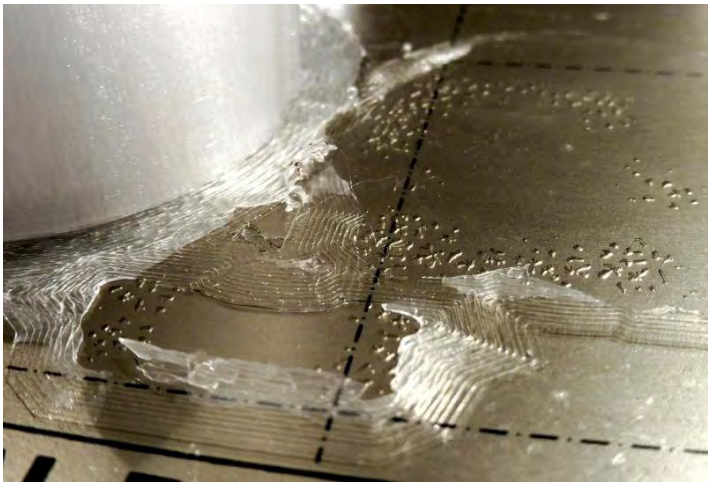


Results: It worked! No significant issues with the print. There were a few spots of "blackened filament" – one inside the SAC and one near a bird peg hole, but nothing major.

Part removal was problematic. There were areas where the brim appeared separated from the base. The left photo below shows darker "glued on" areas vs. lighter (possibly) separated areas.

The right photo below shows the result of what I think are areas of the PEI that had insufficient Magigoo to act as a releasing agent / layer. After removing the main parts and the lifted brim areas, it took an hour with plastic and metal spatulas and fingernails to pick / pry the remains of the single-layer brim – the "too well stuck" areas – off of the PEI print surface.

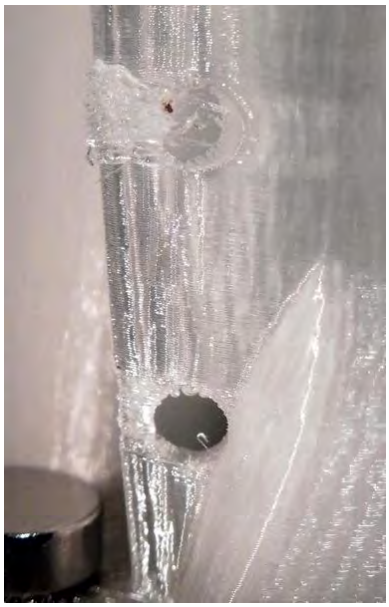
Brim showing stuck vs unstuck areas



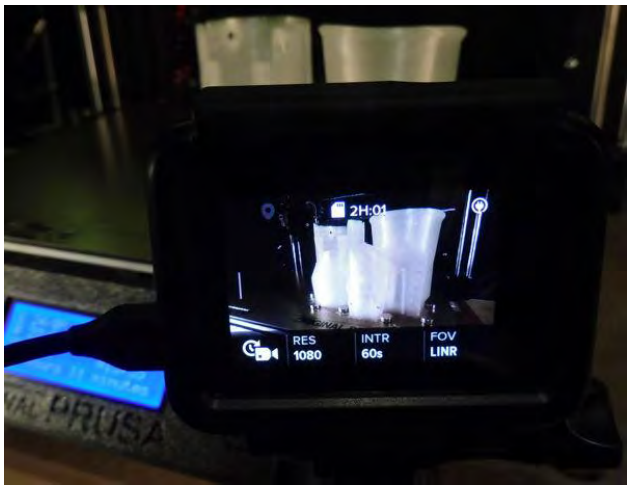
Bubbles, lifed areas, and areas that were too stuck.

Also , there were significant bubbles under the PEI. It's clear that the bubbles are not on the surface of the PEI, but underneath. However, you can feel a general raise in height in the area of the bubbles.

The bird peg holes seemed to come out somewhat better than the last print, but still not great.



Video was not so great. The printed parts were too close to the camera, and the GoPro did not focus well.

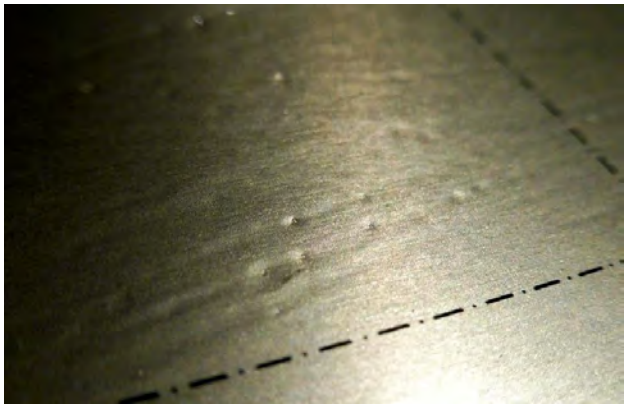


Magigoo support query 5/28/2018

Hi Magigoo folks –

I'm stuggling a bit here, and really want to progress toward being able to reliably use Magigoo to print my flutes … hope you can assist. This is a long tale (for background) with some specific questions at the end.

Recently moved from PLA to nGen – a copolyester with somewhat more shrinkage issues. I'm on a Prusa i3 MK3 with a PEI sheet on a bendable Spring Steel Bed. My prints run 14 hours. I've been warned about the dangers of copolyesters sticking too well to a clean PEI sheet and destroying it. So, I'm primarily using Magigoo as a releasing agent.



Attempted two prints by first cleaning the PEI with Isopropyl Alcohol 91%, then applying Magigoo as recommended. With this bed prep, the Magigoo goes on fairly smoothly, but has bubbles which get frozen when the Magigoo dries. Not sure how to deal with that … pic at the right.

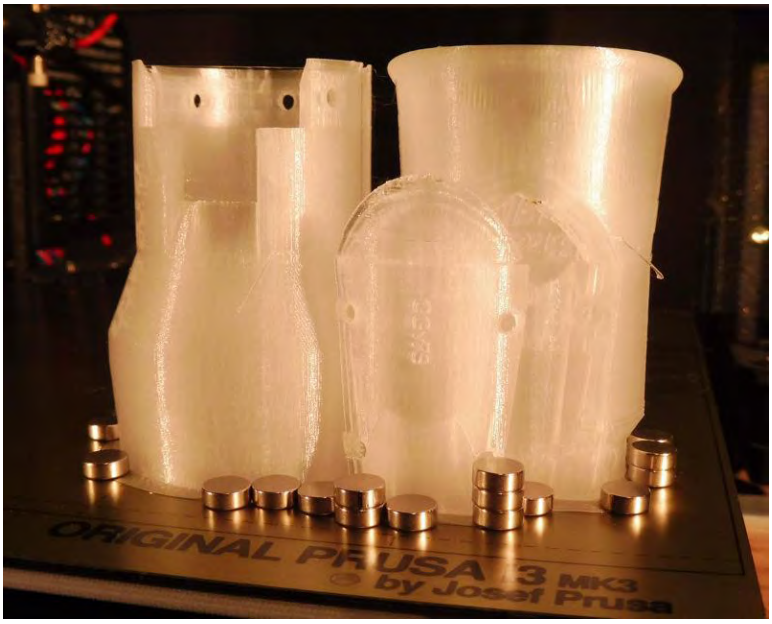
On both prints, the bond between the PEI and Magigoo failed, but the Magigoo seemed well stuck to the nGen print:

I did try one run using Windex Original as a releasing agent, but that failed badly with the print coming unstuck from the bed very early.

For the next print … brainstorm … I started adding magnets. My print has a 10-perimeter, one-layer brim, so I paused the print and add a few magnets to the brim. Seems nice and secure.

However, notice the green arrow, where the brim is visibly stuck to the bed, versus the red arrows where the brim seems to have separated.

Fast forward 8 hours … the extruder starts banging into the print … one side has lifted off and two of the magnets are off the brim. I strike back with a barrage of 20 more magnets. Some grab onto others and stack themselves up two or three-high. *No problem!*

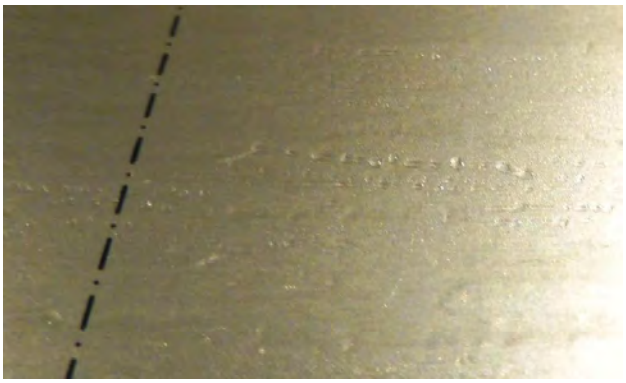


Print finished, but was unusable because of the damage during the banging phase.

On removing the print, it again seemed that the bond between the PEI and Magigoo had failed.

Advice from some Prusa forum users suggested that the PEI was not sufficiently clean to hold the Magigoo. Cleaned the bed with water, to remove prior layers, then a good rub with Acetone. Let it dry.

After shaking well, I let the bottle stand inverted this time to let the bubbles from the shaking rise away from the applicator. That did seem to help (not sure). However, the behavior of the Magigoo after the Acetone cleanse seems somewhat different than after the IPA cleanse. The Magigoo beads up badly – differently on different parts of the bed (pic at right).



I smoothed out the Magigoo with a credit card while it was wet, which did smooth it out and reduce the beading. But it now seems that the Magigoo coverage is not even, with noticable stripes of different shinyness. (pic below).

I'm printing now, so no results with this setup yet … but I wanted to get some feedback on these questions:

1. How can I diminish / suppress / prevent bubbles in the Magigoo using the foam applicator?
2. Does Magigoo spread differently after an Acetone cleaning (*vs.* IPA)?
3. Have you seen Magigoo beading up before, and do you have any advice in this area?
4. Do you recommend spreading out with a credit card?
5. Is there another application method that might be preferable / more reliable than the foam applicator?
6. Do you have experience with nGen versus, say, PETG? Prusa's recommendation for PETG is the same as for nGen – do not print PETG directly on the PEI bed because of super-strong adhesion.

Any thoughts, ideas, advice would be welcome!!

Response on 6/6/2018

From Andrei from Magigoo.com <andrei.andy.linnas@magigoocom.intercom-mail.com> :

Hi Clint, sorry it took a while. We are currently pushing many agendas. To reply to your questions

1. How can I diminish / suppress / prevent bubbles in the Magigoo using the foam applicator?

The trick to avoid the formation of bubbles is to first shake the bottle slowly so as to not introduce air to the mixture. This can be done by gently inverting the bottle from top to bottom about 20 or so times, no need for vigorous shaking. Magigoo separates into two layers so these must be mixed in order to keep the composition consistent. Secondly when it comes to application, give some time to the air bubbles to flow to the bottom part of the bottle (which is now facing upwards) and most importantly gently press the applicator against the build surface until you see some magigoo flowing out. It is very important not to squeeze the bottle at this stage, if no magiggo comes out gently tap the applicator with the build surface until some magigoo flows out. There is a spring loaded valve inside the applicator which lets glue flow out when you push it against the build surface. If after repetition of several attempts no magiggo flows out you can gently squeeze the bottle at the risk of some bubbles forming. Once magigoo flows out genly start spreading it back and forth on one direction whilst keeping a small amount of pressure on the surface just to keep the valve inside the applicator open. Once finished spreading in one direction you can then gently pass the applicator in a perpendicular direction agin back and for but this time keep a very light pressure, the valve should not be opened, this step is just to smooth out the layer of magigoo and remove any bubbles.

2. Does Magigoo spread differently after an Acetone cleaning (vs. IPA)?

To our knowledge unless the PEI layer has had its properties altered by some chemical in windex, or through cleaning with acetone at elevated temperature, the wetting (spreading) of Magigoo on PEI should not be affected. One note about using windex, since it contains a detergent it would actually hinder adherence considerably and thus will cause the print to fail. Furthermore the build surface must be cleaned very well since even trace amount of detergents can have have a dramatic effect on adhesion

3. Have you seen Magigoo beading up before, and do you have any advice in this area?

Since Magigoo is water based it would bead up mostly on hydrophobic surface such as HDPE, grease and wax.

4. Do you recommend spreading out with a credit card?

If the magigoo is coming out of sachet we usually recommend a credit card or something similar to spread it, however the bottle applicator should give better results.

5. Is there another application method that might be preferable / more reliable than the foam applicator?

The foam applicator usually works very well, one can also try spreading it out by gently wiping it around the surface with a paper towel.

6. Do you have experience with nGen versus, say, PETG? Prusa's recommendation for PETG is the same as for nGen – do not print PETG directly on the PEI bed because of super-strong adhesion

nGen does not seem to work well with Magigoo, on the other hand Magiggo users have reported that Magigoo works well as a release agent for PETG on a PEI bed. What we recommend is to adjust the first layer so that the nozzle is a slightly further away from the surface than usual when using Magigoo, this should also help with the release as the first layer would not be squashed closely to the build surface.

I hope some of these questions got an answer.

Thanks, Andy

Releasing Agents

Pretty much giving up on Magigoo, because of the failures, inconsistent application, bubbles, beading, poor coverage leading to a near-ripping of the PEI. So, despite the support message sent to them, I'm running down other choices. Had good luck with the Kores glue stick on the (admittedly small) calibration cube, so …

5/28/2018 Glue Stick

Investigated the best / ultimate Glue Stick to use. The Prusa-provided glue stick (Kores) is not available in the U.S.

Found a recommendation on the Ultimaker forum for UHU Stic Glue Stick. Information on the recommendation and the UHU web site saved in `/Materials/UHU_GlueStick`. Found it on Amazon. Ordered the Saunders UHU 99655 Glue Stick, 1.41 oz. (40g), Clear/White – the largest of them since there is a large area to cover and want to cover it as smoothly as possible.

5/29/2018 3DLAC

In addition to the Glue Stick, purchased a can of 3DLAC on EBay ($39.95). From the EBay listing:

> The properties of 3DLAC cause that while the base is hot the extruded plastic by the head is strongly adhered. On cooling, the printed part is released smoothly and without damage.
>
> TECHNICAL SPECIFICATIONS
>
> Their characteristics are: Its fastening formula is perfect for holding and removing the part after printing is complete. Do not hit, just hold. A revolutionary spray that will mark a before and after in the exciting world of 3D printing.
>
> ABS, PLA and several other materials stick very well to heated glass at regular heatbed temperatures. This product does not work with Nylon. 400ml
>
> Contents : - Isopropyl alcohol - Methylal - Isobutane - Propane - VP/VA copolymer - Alcohol denat - Parfum (Benzyl alcohol, Benzyl salicilate, Coumarin, Geraniol, Butylphenyl Methylpropional, Linalool, Benzyl benzoate, Citronellol, Alphaisomethylionone, Hydroxycitronellal, Amyl cinnamal.
>
> Properties of 3DLAC®: Great adhesion between the base and the melting plastic. Especially suitable for large parts.Valid for PLA, ABS and many Thermoplastics. Between more base temperature, more adhesion. Once cooled the heatedbed the part is released with ease. Easy to clean with water, it is soluble. Valid for more than 400 uses.

Filament Selection

Took stock of where we are with choice of filament. Thoughts:

- PLA is great to print, but unusable because of low temperature tolerance.
- nGen is OK … probably workable (eventually) once a releasing agent is found and the proper settings are dialed in. However …
- Clear filament is probably out. It just doesn't cut it – lettering is unreadable, the inside structure of the print (which can be seen through the translucent sidewalls) is distracting.
- Considered PET-G, but could not find one in a nice color. Color has become a surprisingly important attribute – especially with the predominance of bright, cartoonish colors. Considered the Bomber Jacket Brown and Dark Blue from MakerGeeks, but I had a bad experience ordering from them previously (6 weeks, no order, lots of excuses, then they didn't refund my $$ when I cancelled). Black does not seem tenable (Vera's assessment).

Found a supplier of nGen Lux – Printed Solid (www.PrintedSolid.com) and purchased one roll (750g) of Champagne Gold color ($85 + $6.50 priority shipping) Comparable price direct from ColorFabb was $106 and a much longer delivery time.

Sandpaper

Because some of the components (only SandB at this point, but maybe others in the future) depend on the thickness of sandpaper, here is some info on the various grit sizes, together with measurements taken on 6/1/2018.

Grit sizes are ANSI or CAMI (USA). Approximate FEPA / Euro and APEX / Structures Abrasives sizes are also provided, as well as Regular Micro-Mesh, Aluminum Oxide Micro-Mesh (AO) for solid surface countertops and aluminum polishing, Micro0Mesh MX (MX) for metal finishing and hard materials, and Micro-Mesh Diamond (MXD) for hard metal, alloys, ceramic, and Granite/Marble.

The Micron sizes (µ) listed in the titles are from the Micro-Mesh Grit Size Comparison Chart (http://www.sisweb.com/micromesh/conversion.htm):

100 Grit

- 3M Pro Grade (Red surface, Tan back) 150 Medium Grit (731U): 9″ × 11″ × **0.58 mm**.

150 Grit

- 3M Pro Grade (Red surface, Tan back) 150 Medium Grit (731U): 9″ × 11″ × **0.34 mm**.
- 3M Aluminum Oxide 150 Grit (336U): 9″ × 11″ × **0.27 mm**.
- Aluminum Oxide Abrasive Paper Open Coat Electro Coated Resin Bond150C Grit: 9″ × 11″ × **0.38 mm**.

180 Grit (80µ)

FEPA: P180; APEX: A-110; Micro-Mesh: 300 AO, 120 MXD

- Industrial Abrasives (Grey surface, light grey back) 180 Grit Paper: 9″ × 11″ × **0.26 mm**.

220 Grit (62µ)

Norton SandWet guide: *For removing raised fibers and blending repairs.*

FEPA: P230; APEX: A-85; Micro-Mesh: 60 MX, 180 MXD

- 3M Pro Grade (Red surface, Tan back) 220 Fine Grit (731U): 9″ × 11″ × **0.30 mm**.
- 3M Aluminum Oxide Production Sand-Pak Open Coat, Cat No. 9000, 220 Grit Extra Fine (5PA03): 9″ × 11″ × **0.24 mm**.
- 3M Wetordry Tri-M-ite Paper Awt. (Black surface, Dark brown back) 220 Grit Silicon Carbide Paper: 9″ × 11″ × **0.33 mm**.
- Mercer Abrasives Aluminum Oxide 220A Grit paper: 9″ × 11″ × 0.29 mm. I measured the thickness on November 29, 2017 as 0.0105″ or 0.2667 mm.
- Industrial Abrasives (Grey surface, light grey back) 220B Grit Paper: 9″ × 11″ × **0.23 mm**.

320 Grit (43µ)

Norton SandWet guide: *For sanding between coats to remove bubbles and dust.*

FEPA: P380; APEX: A-48; Micro-Mesh: 600 AO, 180 MX

- 3M Pro Grade (Red surface, Tan back) 320 X-Fine Grit (213U): 9″ × 11″ × **0.24 mm**.
- Je?? Wa?? 320A Grit paper: 9″ × 11″ × **0.23 mm**.

400 Grit (30µ)

Norton SandWet guide: *For sanding prior to final coat of lacquer, paint, or varnish.*

FEPA: P700; APEX: A-48; Micro-Mesh: 1500 (color Rust), 1500 AO, 240 MX, 400 MXD

- 3M Pro Grade (Red surface, Tan back) 400 X-Fine Grit (213U): 9″ × 11″ × **0.23 mm**.
- Norton SandWet (Black surface, Tan back) 400 Super Fine Grit (QK-2): 9″ × 11″ × **0.18 mm**.
- Norton Tufbak Durite (Black surface, Dark brown back) 400 Super Fine Grit (T421, 58L3): 9″ × 11″ × **0.19 mm**.

600 Grit (15µ)

Norton SandWet guide: *For final sanding prior to polishing.*

FEPA: P1300; APEX: A-12; Micro-Mesh: 1800 (color Green), 1800 AO, 520 MXD

- 3M Wetordry Tri-M-ite Paper Awt. (Black surface, Dark brown back) 600 Grit (MA31): 9″ × 11″ × **0.18 mm**.
- Norton SandWet (Black surface, Tan back) 600 Ultra Fine Grit (QK-2): 9″ × 11″ × **0.16 mm**.

800 Grit (13µ)

Norton SandWet guide: *For generating a matte finish.*

FEPA: P1500; APEX: A-10; Micro-Mesh: 2400 (color Black), 2400 AO, 320 MX

- Norton SandWet (Black surface, Blue back) 800 Grit (BlackIce / T214 / 68F): 9″ × 11″ × **0.20 mm**.

1200 Grit (9µ)

Norton SandWet guide: *For generating a satin finish.*

Micro-Mesh: 3200 (color Tan), 3200 AO

- Norton SandWet (Black surface, Blue back) 1200 Grit (BlackIce / T401 / 64F): 9″ × 11″ × **0.18 mm**.

1350 Grit (8µ)

Micro-Mesh: 3500 (color Wine / Brown), 3500 AO

1500 Grit (5µ)

Norton SandWet guide: *For generating a gloss finish.*

APEX: A-05; Micro-Mesh: 4000 (color Teal), 4000 AO, 600 MX, 1500 MXD

2000 Grit

Norton SandWet guide: *For touch-up repairs on a high gloss finish.*

2000 (Est) – Micro-Mesh Hyper-fine Purple

Micro-Mesh: 6000 (color Purple) – estimated 2000 grit

2500 (Est) – Micro-Mesh Hyper-fine Royal Blue

Micro-Mesh: 8000 (color Royal Blue) – estimated 2500 grit

3000 (Est) – Micro-Mesh Hyper-fine Gray

Micro-Mesh: 12000 (color Gray) – estimated 3000 grit

Glued-up Sanding Blocks

Measurements taken on sanding blocks glued up on 6/3/2018:

- Sanding block prior to gluing: 9″ × 2″ × **19.02 mm**
- Sanding block + 3M Pro Grade (Red surface, Tan back) 220 Fine Grit (731U): **19.30 mm**
- Sanding block + 3M Super 77 Spray Adhesive + 3M Pro 220 Grit: **19.32 mm**

The 3M Pro 220 Grit was previously measured at 0.30 mm, so there is a 0.02 mm discrepancy above in the first or second measurement. A single-sided layer of 3M Super 77 Spray Adhesive seems to add 0.02 mm to the "sandwich".

6/5/2018 Finishing Work

Sanding tube – the outside of a bell-end 1″ PVC.

Strips glued to the `SandN` component (photo at right).

Sanding Sticks

On 6/6/2018, purchased supplies to fashion sanding sticks consisting of a popsicle-style stick and sandpaper, backed by 3M VRB double-sided adhesive tape. The sticks are Darice 9150-82 Wood Craft Colored Stick, 4½″ × 3/8″, 120-Pack.

3M VHB Tape

3M VHB Tape consists of a durable acrylic adhesive with viscoelastic properties. This provides an extraordinarily strong double-sided foam tape that adheres to a broad range of substrates, including aluminum, stainless steel, galvanized steel, composites, plastics, acrylic, polycarbonate, ABS and painted or sealed wood and concrete. These bonding tapes provide excellent shear strength, conformability, surface adhesion and temperature resistance. They are commonly used in applications across a variety of markets including transportation, appliance, electronics, construction, sign and display and general industrial. Reliably bonds a variety of materials with strength and speed for permanent applications.

RP16

- Thickness: 0.016 in. (0.4 mm)
- Density: 45 lb./ft.3 (720 kg/m3)
- Peel Adhesion: 12 lb./in. width (210 N/100 mm)

RP25

- Thickness: 0.025 in. (0.6 mm)
- Density: 45 lb./ft.3 (720 kg/m3)
- Peel Adhesion: 17 lb./in. width (300 N/100 mm)

RP32

- Thickness: 0.032 in. (0.8 mm)
- Density: 45 lb./ft.3 (720 kg/m3)
- Peel Adhesion: 18 lb./in. width (315 N/100 mm)

RP45

- Thickness: 0.045 in. (1.1 mm)
- Density: 45 lb./ft.3 (720 kg/m3)
- Peel Adhesion: 20 lb./in. width (350 N/100 mm)

RP62

- Thickness: 0.062 in. (1.55 mm)
- Density: 45 lb./ft.3 (720 kg/m3)
- Peel Adhesion: 20 lb./in. width (350 N/100 mm)

Mortice Reamer

Gave up on using sanders for reaming out the mortice at the foot end of the flute.

Reed Manufacturing PPR125 pipe reamer (image at right). The catch may be that this tool assumes that it is being centered on an inner core that is most likely the inside diameter of Schedule 40 PVC. The Breath Flute uses a chamfer at the head of the mortice, and closes down to a diameter that is less than the inside diameter of a Schedule 40 1¼ ″ pipe, so this may be a problem …

We also need a way to ream out that diameter at the head end of the sound chamber, which is not a standard size.

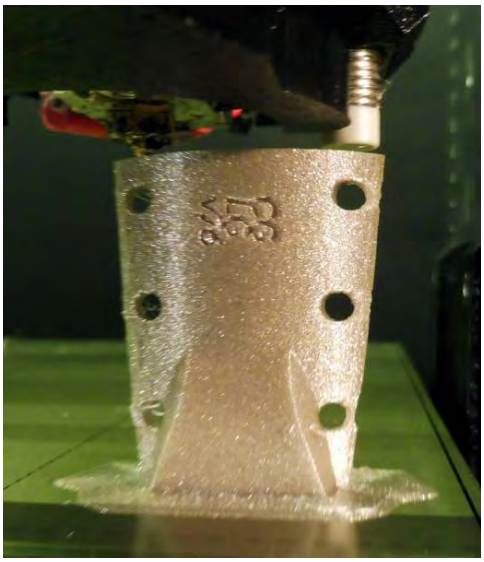
Body Tube Suppliers

Began looking for sources for better body tubes than Home Depot or Agri Supply houses. Here are some sources to consider:

- FlexPVC has thin-walled furniture grade PVC, but it is being discontinued and they only have “what we have left”.
- FormUFit has thin-walled 1″ and 1½″ Furniture Grade PVC in many colors, but it does not look like 1¼″ https://assets.formufit.com/tsd/TSD-P114FGP.pdf

- C&S Plastics, which has Schedule 5 (they call it "Thinwall-065") 1¼" tubing in many glossy colors! http://candsplastics.com/. I put in a request for a quote for sample pieces.
- Consider a PVC Jacketing product such as the FormUFit "PVC Size PipeSleeve Shrink Covering" (https://formufit.com/collections/pvc-pipe/products/1-1-4-in-pvc-size-pipesleeve-shrink-covering-10-feet). It goes over your PVC and fixes with heat-shrink. Other similar products:
  - http://www.buyinsulationproductstore.com/pvc-cut-and-curl-jacketing-w-ssl-3ft/
  - http://www.buyinsulationproductstore.com/color-pvc-fittings-and-jacketing/

6/6/2018 Print of current BI v76 component in nGen-Lux



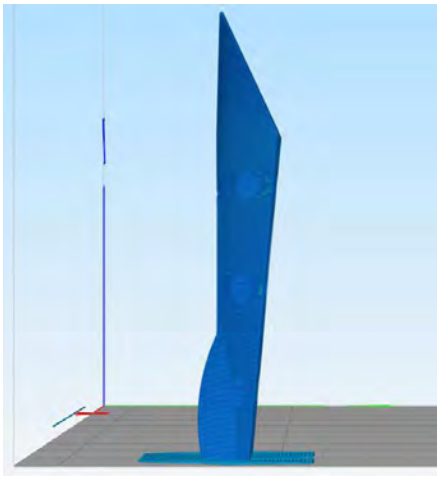
A test of nGen Lux.

- **Printed:** June 6, 2018
- **Source:** `BFlute_076.scad`
- **STL:** `BFlute_076_BI_CG_f125ml_20180603_0849.stl` (3.9 MB)
- **Factory:** `BFlute_076_BI_CG_f125ml_20180603_0849.factory`
- **Profile:** `Pi3Mk3_BF_CG_nGen_Brim16.fff`
- **Based on:** `Pi3Mk3_BF_CG_nGen_Brim16.fff` (see above)
- **G-code:** `BFlute_076_BI_CG_f125ml_20180603_0849.gcode` (3.3 MB)
- **Slicer:** Simplify3D 4.0.1. No profile modifications
- **Printer:** Pi3Mk3/CG, 0.40 mm brass E3D nozzle
- **Bed Prep:** Cold Prusa PEI SSS. Warm water good scrub with paper towels. IPA 91% – good scrub with paper towels. 3DLAC, shake can and apply a thin spray from 1 foot above the bed on the front right corner of the bed.
- **Filament:** ColorFabb nGen Lux Champagne Gold 1.75m

> **Note:** the newly opened box of nGen Lux was not vacuum sealed. It easily "breathed" in air. At first, I thought it was the overlap on the sealing edge (left picture), but then I also noticed the rip in the side of the bag (right picture). The rip lined up with the circular edge of the filament spool, so I suspect it had been pressed on from the side (surprising, given how sturdy the box is). Well, it's a long trip from The Netherlands.

- **VidSetup:** (none)
- **Video:** (none)

- **Predic build time:** 2h 6m, Fil. length: 1.948 m, Plastic weight: 5.86g (0.01 lb), Cost 0.27
- **Live Tuning:** (none)
- **Actual build time:** 2h 15m
- **Printed part marked:** *(not marked)*



NOTE that S3D slices the G-code so that most of the print runs at 435 mm/min (= 7.25 mm/sec) – dangerously close to the minimum print speed of 6 mm/sec that triggers the "Bulge Jam" scenario. However, this did not seem to be a problem.

NOTE: took a screen snapshot from S3D showing the bird from the side and the angle that the bird is built up at (inviting it to "tip over"). This was mentioned in a TBD earlier. Fixing this – designing the Bird so that it is more vertical – would cause the face of the Bird to cant back toward the player rather than forward, which is probably what we want …

Removal of the part from the 3DLAC / PEI bed was a bit difficult, but not too bad. I was able to remove the part by bending the vertical bird component itself … prying underneath the brim was not so successful.

Results: Gorgeous!!!

6/6/2018 Print of current BP / BD v76 component in nGen-Lux

Decided to print the rest of the headjoint in nGen Lux.

- Printed: June 6, 2018
- Source: `BFlute_076.scad`
- STL:
  `BFlute_076_BP_CG_f125mli3_20180531_1034.stl` (17.6 MB)
  `BFlute_076_BD_CG_f125i3z5e5_20180531_1034.stl` (7.5 MB)
- Factory:
  `BFlute_076_ZZ_CG_f125mli3_20180531_1034.factory`
- Profile: `Pi3Mk3_BF_CG_nGen_Brim16.fff`
- Based on: `Pi3Mk3_BF_CG_nGen_Brim16.fff` (see above)
- G-code: `BFlute_076_ZZ_CG_f125mli3_20180531_1034.gcode` (43.3 MB)
- Slicer: Simplify3D 4.0.1. No profile modifications
- Printer: Pi3Mk3/CG, 0.40 mm brass E3D nozzle
- Bed Prep: Added a bit more 3DLAC to the already prepared bed from the first print. Printing in a different area on the bed – front center.
- Filament: ColorFabb nGen Lux Champagne Gold 1.75m
- VidSetup: (none)
- Video: (none)
- Predic build time:
  11h 12m, Fil. length: 31.237 m,
  Plastic weight: 93.92g (0.21 lb), Cost 4.32
- Live Tuning: (none)
- Actual build time: 13h 13m
- Printed part marked: *(not marked)*

Results: Fantastic ! ! !

However … I cracked the BodyDist trying to insert the BodyProx before it was properly trimmed / sanded. Small crack at the base of the top-most mortice (below the Peg Holes) on one side. Probably not fatal, since the Peg set screws will hold it in place, but it does point out a weakness in the design …

6/8/2018 Trial Balloon Release

First release package (non-public) sent to Jon Norris for review.

The release directory was `/BreathFluteRelease_076_20180508_0711`. Archiving this directory using *Windows File Explorer* vs. *7Zip* produced these results:

```
BreathFluteRelease_076_20180508_0711_UsingWindowsZip.zip     31,043 KB
BreathFluteRelease_076_20180508_0711_Using7Zip.zip           28,903 KB
```

I posted the *7Zip* version to Jon.

Breath Flute #77 – Improvements Beginning 6/8/2018

The issues addressed in this version …

- Fix the top and middle peg holes, which tend to go too deep. Render to STL and measure them in 3D tool. Can also make the Bird Peg Hole Box less deep. *Generally addressed in v77 at some point, by the complete overhaul of how Bird pegs are done.*
- Specialized brims that accommodate magnets?? ***TBC (to be considered)***
- What if we set it up so that the start-end points were inside the inlay channel! i.e. underneath the inlay!! ***TBD***
- May need a custom Brim for the `Bird` component, specifically to not attach the brim on the underside of the flue exit (where it would interfere with the chamfer), but attach it on all other quadrants, including the underside on the sides, where they can be filed off flat. This is problematic, because not attaching one side of the `Bird` to the brim is asking for it to fall over. ***TBD***
- Consider a sanding tool for the front lip of the bird – to restore the chamfer after removing the brim. ***TBC***
- Consider providing a raised plate ("platform", "dais"?) for the "Breath Flute" inscription on the `BodyDist` component. The platform would facilitate filling-and-sanding (Woodfill? Sculpt Wood? Engraving Filler Stick / Putty?) The platform could both raise at the edges and cut into the circumference of the `Headjoint`. Four separate platforms, two on the TSH cylinder area and two on the Flare. ***TBC***
- Locate engraver's filler to fill in the Breath Flute logo – Stew Maclen Laskin engraving filler? Bowling Ball engraver filler? Markforged Engraver Filler labelling article? ***TBD***
- Consider printing the logo in Reverse in a different color and snapping it in. Is this feasible?? Too finicky?? ***TBC***
- Investigate fonts specifically for use with the Breath Flute … a fixed-pitch font for things like version numbers (that are currently subject to variability in positioning because the width of digits varies). Also, match the Breath Flute logo on the model to the one used in the logo? *Done – 6/14/2018 – Now using Kurinto Mono where appropriate. Also (!!) discovered the centering ability for text (!!) and used it where appropriate.*
- Smooth out the transition from the ramp to the flue with an "eased" / curved transition. This involves the center curved section and the side straight sections. ***TBD***
- Move the top peg hole down a bit so that it does not cause a "bump" in the SAC area. *Done – 6/12/2018 – along with reduction to 4 bird peg holes.*
- Maybe use the new Bird Peg Back Box construction to widen the platform for the bird, making the bird wider and more robust. *DONE – 6/8/2018 – new Nest areas provide this feature.*
- Add Bolt Holes and Nut Slots to the bottom of `SandB` and `SandC` (and other components?) to allow them to be bolted down. ***TBD***

- Make the sides of the `SandN` component higher – even 220 grit sandpaper (Mercer Abrasives 200A) is thick enough to cause the sides to be very shallow and not so effective as guides. *Avoided – 6/11/2018 – altered the shape of the Flue so that the SandN component is no longer needed.*
- Beef up the top mortice in the `BodyDist` – it ***cracked*** in the first nGen Lux print. External beefy "blades" for strength? Or … maybe use *no* mortice and make the tenon in the BodyProx component smaller – which will change some of the longitudinal measurements. This will have the advantage of having one less diameter to ream / sand out … *DONE – 6/8/2018 – configuration of the flare area changed, and created new JunctionProx and JunctionDist components to facilitate development work in this area.*
- Need to beef up the Nest area. The peg holes in the Bird are just too shallow /weak / malformed. *DONE – 6/8/2018 – new Nest areas with a complex curve shape, and moving the bird construction away from the centerline of the instrument to place it on top of the new Nest.*
- Need to include the SIL OFL license files with the font release! *DONE – 6/10/2018.*
- Need to look into David Eccles's latest `Bioinfscripts` delivery – email from David and GitHub update on 5/28/2018. *Done – 6/18/2018 – New version does not seem useful. See the Path Extrude section below.*
- Change the code for mouthpiece size in .stl file names from "`ms`", "`mm`", "`ml`", and "`mx`" to "`S`", "`M`", "`L`", and "`X`" – far easier to identify. *DONE – 6/9/2018.*
- Rename the "ProxDist" Pegs to "Junction" Pegs, with the tag "`JnctPeg`" in the code – matches the 4 characters of the "`BirdPeg`" tag and regularizes the code nicely. *DONE – 6/9/2018.*
- The new Nest has produced pointy "nubs" on the `SpEdge` components … trim them off. *Done – 6/18/2018 – Removal of the Nest generation for SpEdge components – done some time ago - cured this issue.*
- Experiment with how the OpenSCAD model behaves when you change pipe sizes. ***TBD***
- Develop sanding "dowels" for the various bore sizes – two half-cylinders that can be combined with a spacer (bond paper) to keep enlarging them – or maybe even foam of various thicknesses – something springy! ***TBD***
- Develop cone-shaped tenon sanding wedges (or "cones") for the bevel on the tenon of the `BodyDist` component and the diameter-transition bevel on the inside of the sound chamber bore. ***TBD***
- Develop inverse-cone sanding wedges for the bevel at the base of the Junction of the `BodyProx` component. ***TBD***
- Develop CDR-based templates (delivered as PDFs) for the outline of the sandpaper to cut for the cone-shaped sanding wedges. See the /HowTo articles on Cone Templates as well as the XLS from the FoamConeSander article. ***TBD***
- Add a factor to scale the tenon at the foot of the `BodyProx` component slightly smaller, so that it fits nicely into the `BodyDist` component. ***TBD***
- Add a parameter / option on the model for Bolted vs Tied bird? ***TBC***

- SIL OFL license has been added to the license statement in the Developer's Guide – it needs to be reflected in all other locations. *DONE – 6/12/2018.*
- Develop a separate module for Standard Polygons – rectangular, Pentangular Prism, etc. Needs to have an integrated or associated diagram facility to be useful. ***TBC***
- Add flat faces on the sides of the Nest – to give it a less rounded, more angular look that echoes the distal end of the Bird. Probably should not affect the sliced Bird component. ***TBC***
- Consider a "Z" or "S" type of back to the Sanding Dowel components so that they mate with each other and form a more positive lock versus just aligning them. The "S" curve would be the same on both pairs of components. Downside is that the sandwiching of the end of the strip of sandpaper becomes a bit more problemantic. ***TBC***
- Develop the new `SandG` component – the Sanding Grip to protect the Grip at the bottom of Sanding Dowels in the jaws of a vice grip. This component is designed to crush before the Grip crushes, if too much force is applied to the vice grip. ***TBC***
- Straighten out the use of `Smidge`, `Smidge2`, etc in `SplitBodyShapeForBodyProx()` and `SplitBodyShapeForBodyDist()`. This was causing heartburn in a bunch of areas, including the calculation of the angle for the upcoming `SandQ` component. It was also causing unnecessary fudge factors (`FlareFudge`), causing micro steps in the supposedly flat bottom of `BodyProx`, and promoting *PolySet has nonplanar faces errors* from `CGAL`. *Done – 6/16/2018 addressed in a marathon session to check all uses of* `Smidge` *and reduce them where possible (lots of cases). Eliminated fudge factors and eliminated some of the Nonplanar Faces errors.*
- There are still a number of *"PolySet has nonplanar faces. Attempting alternate construction"* errors generated by `CGAL` on an `F6` Rendering. 16 pairs of errors in the components `BodyProx`, `Headjoint`, `Body`, `BPBird`, `HeadjointHalf`, `BodyHalf`, `BodyProxHalf`, and `Lip`. Looks like the error stems from `Lip`, which would implicate `path_extrude()`. *Done – 6/17/2018. Issue is related to multiple calls of path_extrude(). See the Path Extrude section below.*
- Implement shrinkage factors for the `XYExpand` parameter: e501–e999 represents a shrinkage factor while e000–e500 represents an expansion. *Done – 6/19/2018.*
- For `HalfBody` comonents (`HeadjointHalf`, `BodyHalf`, etc) render only half the `Lip ()` for. *Done – 6/20/2018.*
- The drain holes are missing in the `HeadjointHalf` component. *Fixed – 6/20/2018.*
- Add a MicroBevel to all Sanding Tools to counteract elephant's feet. ***TBC***

6/8–12/2018 Upgrades to the Model

Major expansion of (and additional complexity added to) the model to address these issues:

Nest

The new Nest area under the Bird was developed on 6/8–9/2018. It has a complex curve shape, and allows the bird assembly to be moved away from the centerline of the instrument to place it on top of the new Nest.

The shape is variable depending on the `MouthpieceSize`. Also, the shape does encroach onto the `BodyDist` component, so this might mean that `BodyDist` depends on the setting of `MouthpieceSize`.

Flue Shape

Eliminate the "bump" or "island" that existed at the floor of the flue, which prevented it from being sanded straight across and necessitated the `SandN` component. This was a major post-processing hassle and opened the door to wasted parts if the flue floor was accidentally sanded.

This idea was to "flatten" the Y-axis shape of the floor a bit, so that the floor does not intersect the plane of the cut made to separate the Body from the Bird. This was formerly done by a nasty bit of code that used a second `FlueCavity()` to eradicate the "island".

The Flattening was done in a new version of the `FluteCavity() – PRF2`. Here is the documentation of that routine:

```
// This is a variant of PRF1 that uses a "Differential Flue Radius". The idea
// is to flatten the flue in the X dimension – to make it follow a shallower
// curve than the radius of the bore, in order to solve the problem of the
// floor of the flue sticking up above the plane of the Nest rails.
// This "sticking up" issue was preventing the
// Nest rails from being sanded straight across, and necessitated the
// SandN component.
// Using PRF2 solves that, but executing rotate_extrude () on a radius that
// is different from – larger than – the actual radius of the flue from the
// centerline of the instrument. After the rotate_extrude() operation,
// the flue is slid back down. The use of the Differential Flue Radius in
// PRF2 necessitates corresponding changes in the splitting edge and the
// shape of the SAC above the flue.
```

Splitting Edge

The splitting edge was upgraded to shadow the same differential shape as the flue.

FlueCavity() Invocation

The rather expensive `FlueCavity()` module was used repeatedly for lots of situations throughout the code. This repeated use was eliminated with a new `DelayedFlue` and `ImmediateFlue` flag that controls when the `FlueCavity()` module is invoked. With `DelayedFlue` turned on, we only call `FlueCavity()` once at the very end of the model, and only for those components that need it.

Flue Cavity in the SAC

One of the issues was that the bottom of the `Bird` changed shape right at the proximal end of the flue. This caused heartburn during sanding, since, for Small `MouthpieceSize`, the SAC cants inward and could not be properly sanded by the `SandB` component.

This was fixed by extending the flue cavity into the SAC in a smooth way. Also, the new `Flue` component (code `FL`) lets you visualize the shape of the flue.

This extension into the SAC changes the shape of the `Flue` based on `MouthpieceSize`, but only in the SAC area. This allows a smooth(er) transition into the flue, customized for each `MouthpieceSize`. However, this means that the `Flue` component is technically dependent on `MouthpieceSize`, but that's not so important since the `Flue` component is only for development and testing.

This development work also caused some issues with the extended flue intersecting and messing up the Lip in some cases. This was handled by a new Flue Bounding Box.

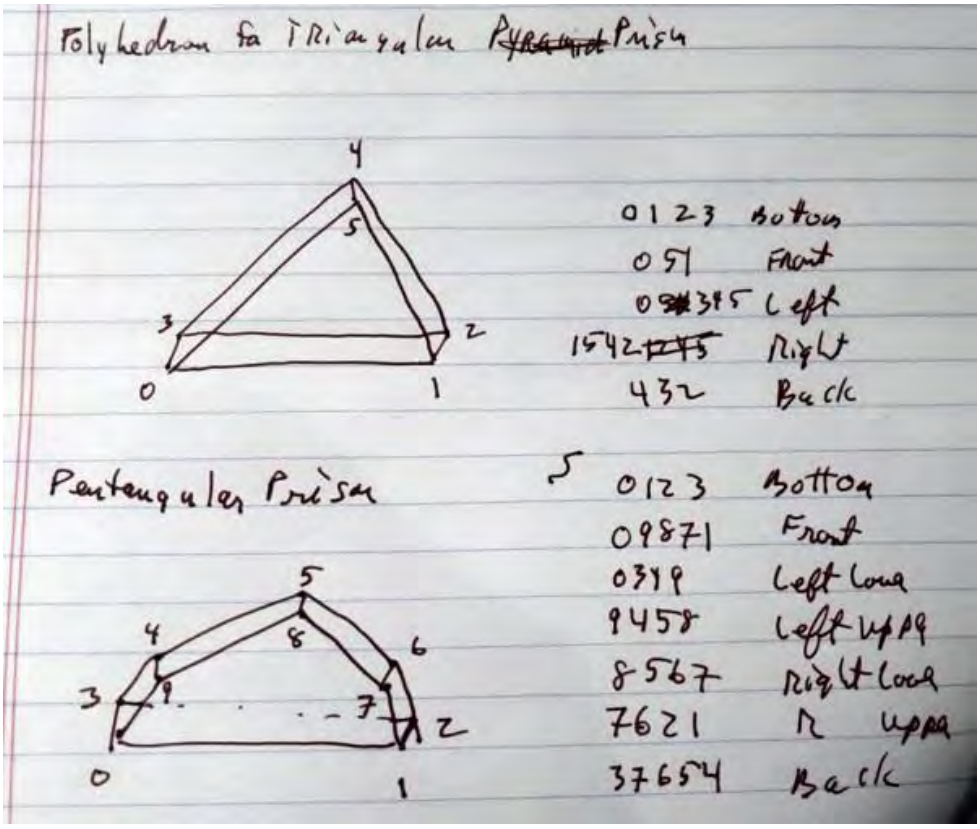
Sanding Tools

The Sanding Tools were greatly expanded to provide specific tools for every component that needs post-processing. Sanding Tools are now classified as Sanding Blocks, Sanding Wedges (for sanding circular bevels), and Sanding Dowels (for reaming out inside tubes). Develop Corel Draw template to cut sandpaper for each of the sanding components.

The `SandN` component is now deprecated, since there is no longer a “bump” at the floor of the flute.

Crown Polygon

Major overhaul in the way the crown is created. See documentation in the code for the `Crown ()` routine. Involved creation of a Pentangular Prism … Here are the mappings of points and faces for the two new polygon shapes:



> ***NOTE:*** The name should be "Pentagonal Prism". The last (Back) face of the Pentagonal Prism should be "32654" – not "37654"! Also, "Right Lower" should read "Right Upper" and "Right Upper" should read "Right Lower".

Flue Backing Box

Developed a dramatic simplification of the solid area behind the flue … the Flue Backing Box. This is a simple, six-sided polygon that handles / replaces the `FlueWall()` (a complex, enlarged version of the `FlueCavity()`), the `BirdPegCollars()` that provide the substance into which the Bird Peg set screws are inserted, and a fair amount of machinery (a custom "BackingBox") to support and avoid overhangs in the `BirdPegCollars()`.

Damage Repair

Fix the fallout from the above changes:

- The location of all Bird Peg Holes need to be moved. They also change size from ¼″ to ⅜″ for the Bird Pegs.
- Printing on the Bird needs to be fixed – it is now buried inside the part.

Damage Repair from the Damage Repair

OK, so the Damage Repair work introduced some more damage. In particular:

- The introduction of the Nest Lettering Base Cone – really just a Nest slid back by BirdLetteringInsetDepth – had some side effects – incursions into the SAC, etc. It also slowed rendering down. The Nest appears to be quite expensive. This was fixed by intesecting the NestShape used for

both the Nest itself and the Nest Lettering Base with small boxes that drastically limit their sizes to what is really needed.

- There is now a ThroatBore ring carved out up into the SAC … needs to be tracked down.

OpenSCAD Forum

http://forum.OpenSCAD.org/, 6/12/2018 clint@goss.com, Username: ClintGoss, Address: discuss@lists.openscad.org

> ClintGoss – Cost for Boolean Operators with One Operand on Jun 12, 2018; 8:31am

```
Is there any cost to using a Boolean operator with a single operand?

My model is large and complex (pushing 10,000 lines) and I often use switches
for testing and optional components. I have a lot of:

  union-difference-intersection () {
    A();
    if (switchVariable) B();
  }

Would there be a rendering speed cost? (it's slow enough already)

Is there added complexity in the generated STL?  (it's big enough already)

I could change to:

  if (switchVariable)
    union-difference-intersection () { A(); B(); }
  } else {
    A();
  }

... but that would make the code far less readable   (it's dense enough
already).

Thanks for any feedback or even musings on this ...
```

I just looked at the source code. The function GeometryEvaluator::applyToChildren3D contains the following:

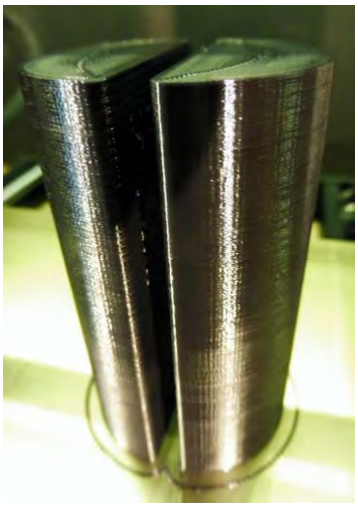
```
// Only one child -> this is a noop
if (children.size() == 1) return ResultObject(children.front().second);
```

So I would say that union, intersection and difference with a single shape argument are optimized to just return the shape.

Thank you so much Doug!

You've not on answered the question, but made me realize that (of course!) I could simply read the source code (Of Course!). Guess years of using closed apps will make you forget that.

6/14/2018 Print of SandY in PLA



Updated SandY design using Rigid.Ink Black PLA with new Breath Flute-Specific profile.

- Printed: June 14, 2018
- Source: BFlute_077.scad
- STL: BFlute_077_SY_CG_f125_20180614_1017.stl (4.0 MB)
- Factory: BFlute_077_SY_CG_f125_20180614_1017.factory
- Profile: Pi3Mk3_BF_CG_Tool.fff
- Based on: Pi3Mk3_BF_CG.fff
- G-code: BFlute_077_SY_CG_f125_20180614_1017.gcode (17.6 MB)
- Slicer: Simplify3D 4.0.1. Profile modifications:
  - Additions: Infill 30%
- Printer: Pi3Mk3/CG, 0.40mm brass E3D nozzle
- Bed Prep: Cleaned with warm water twice. Scrubbed twice with 91% IPA. The 3DLAC smell was pervasive, and did actually linger a bit after the cleaning.
- Filament: Rigid.Ink Black PLA 1.75m (the new replacement roll they sent – which did seem to have brittle filament, at least at the beginning).
- VidSetup: (none)
- Video: (none)
- Predic build time: 4h 17m, Fil. length: 18.927 m, Plastic weight: 56.91g (0.013 lb), Cost 2.62
- Live Tuning: (none)
- Actual build time: 5h 16m
- Printed part marked: *(not marked)*

Results: Print worked great.

Used the two sanding dowels to sand out the Mortice of the nGen Lux print, with 100, 150, and 220 grit using 40 × 170 mm cuts of sandpaper. It worked well. However, need to have a handle and designed a notched handle that works with Walter Shanov's Drill Press Vice.

6/14/2018 Print of SandBC, BF, and BN in PLA

Updated tool designs using Rigid.Ink Black PLA with new Breath Flute-Specific profile.

- **Printed:** June 14, 2018
- **Source:** `BFlute_077.scad`
- **STL:** `BFlute_077_SC_CG_f125_20180614_1913.stl` (8.7 MB)
  `BFlute_077_SF_CG_f125_20180614_1913.stl` (5.6 MB)
  `BFlute_077_SN_CG_f125_20180614_1913.stl` (8.6 MB)
- **Factory:** `BFlute_077_S3_CG_f125_20180614_1913.factory`
- **Profile:** `Pi3Mk3_BF_CG_Tool.fff`
- **Based on:** `Pi3Mk3_BF_CG_Tool.fff`
- **G-code:** `BFlute_077_S3_CG_f125_20180614_1913.gcode` (18.4 MB)
- **Slicer:** Simplify3D 4.0.1. Profile modifications:
  - **Additions:** Infill 30%
- **Printer:** Pi3Mk3/CG, 0.40mm brass E3D nozzle
- **Bed Prep:** Scrubbed once with 91% IPA.
- **Filament:** Rigid.Ink Black PLA 1.75m.
- **VidSetup:** (none)
- **Video:** (none)
- **Predic build time:** 9h 1m, Fil. length: 44.060 m, Plastic weight: 132.47g (0.029 lb), Cost 6.09
- **Live Tuning:** (none)
- **Actual build time:** 11h 36m
- **Cum. print time:** 13d 20h 30m = 332.5 hours
- **Cum. filament:** 349.16 m
- **Printed part marked:** *(not marked)*

Results: printed great.

Profile for Printing Breath Flute Tools – Pi3Mk3 with a 0.40mm Nozzle at LHt 0.10mm

On 6/15/2018, I developed this profile for printing Breath Flute Tools in PLA. It is based on the profile `Pi3Mk3_BF_CG.fff / PLA / High`, which is in turn based on the core profile `Pi3Mk3 Pristine S3D 20180412.fff / PLA / High`.

Here are all the parameters of that profile, with differences from `Pi3Mk3_BF_CG.fff` shown in rpurple and changes from the core profile `Pi3Mk3 Pristine S3D 20180412.fff / PLA / High` Shown in red.

A test of how profile changes affect predicted build time for the current `SandY` component:

- LHt 0.10, Infill 90%, Combine 2 (original): 4h 27m = 267m
- LHt 0.10, Infill 30%, Combine 2: 3h 26m = 206m
- LHt 0.20, Infill 30%, Combine 2: 1h 47m = 107m
  This combination generated a warning: *"The chosen infill layer interval has resulted in an infill width/height ratio below 1.2. This is typically not recommended and may cause poor layer adhesion. Are you sure you want to continue?"* There is no on-line help on this warning.
- LHt 0.20, Infill 30%, Combine 1: 1h 51m = 111m

Profile: `Pi3Mk3_BFT_CG.fff / PLA / High`

Extruder: E-List [PrimExtr], Index Tool 0: Noz 0.40, ExtMult 1.00, ExtWid Man 0.40,
Ooze Control: YES Retr, RetrDist 1.00, ExRestart 0.00, RVertLift 0.00,
RSpeed 2400 mm/min (= 40 mm/sec),
Yes Coast, CoastDist 0.20, Yes Wipe, WipeDist 2.00

Layer: L-Extr: PrimExtr,
LHt 0.20, // *Layer height 0.10 to 0.20 for speed*
TSolid 4, BSolid 4,
Shells 3, *// Highest Yield Stress, based on the [3DMATTER 2015] study*
Dir: InOut, No PISeq, No Vase,
FHt: 150%, *// S3D Default … works well for me. Jo Prusa & Jeff Golden use 200%*
FWid 105%, *// A little extra extrusion to aid in sticking to the bed. Chris Warkocki uses 102%*
FSpeed 35% (@SpDefault of 4800 mm/min → 1680 mm/min = 28 mm/sec), *// Warkocki uses 25 mm/sec, other experienced use 30 mm/sec*
// Start on the back. For the Bird component, the seam will be in critical areas (roof of the flue, // top curved bevel edge), but those areas require sanding in any case.
// Issue: As we move the print around on the bed to handle PEI bubbles … this needs to be adjusted!
StartPts: Use random *// Looks ain't so important … spread around any glitches!*

Additions: Yes Skirt, Sk-Extr PrimExtr, SkLayers 1, SkOffset 3.00, SkOutlines 2,
No Raft, No Pillar, No Ooze

Infill: I-Extr PrimExtr,
IntPat Rect, *// Rectilinear for greatest Max Stress, based on the [3DMATTER 2015] study*
ExtPat Rect, *// Rectilinear, so top surface prints better and also better strength (I think)*
Infill 30%, *// Not the strongest, but 23% faster than the 90% infill used on Breath Flute components*
OutOvr 25%, *// S3D is 20%, KeyboardWarrior 30%, Jo Prusa 25%*
InWid 100%,
MinLen 2.00, *// S3D is 5, Jo Prusa is 2, Chris Warkocki is 1.00*
Combine 1, *// Force infill to print at 0.20 mm – stronger and faster than 0.10 mm*
No IncSolid, DiaphEvery 20,
IntAng: 45 / -45, *// Restore the defaults Defaults*
No EvAngle,
ExtAng: 45 / -45

Support: No GenSupp

Temp: T-List [PrimExtr] T0, TType Extruder, No Layer, No Loop, Yes WaitStab,
SetP 1:210°C / 2:205°C, *// Somewhat arbitrary setting for PLA*
T-List [HBed] T0, TType HBPlat, No Layer, No Loop, Yes WaitStab,
SetP 1:65°C / 2:55°C *// Somewhat arbitrary setting for PLA*

Cooling: FanSpeed 1:0 / 2:100,
No Blip, No Incr, ITime 45sec, MxFSp 100%, No BrFan, BrSpOvr 100%

G-Code: Yes 5D, No RelDist, Yes AllowZ, No Indep, No M101, Yes Sticky, No applyGOffsets,
GOffsets X:0.00 / Y:0.00 / Z:0.00, Yes UpMDef, MType Cart, Build X:250 / Y:210 / Z:210,
Orig X:0 / Y:0 / Z:0, Home X:Min / Y:Min / Z:Min, Flip No X, Yes Y, No Z,
THeadOffsets [Tool 0] X:0 / Y:0,
Yes UpdFirm, FType RepRap, GPX: Replicator 2, Baud 115200

Scripts: Starting Script and Ending Script (see below), others blank
ExpFmt: Standard G-Code, No AddCeleb, AddTermCmd: (none)

```
// Max Print Speed = Max Volume / (Extrusion Width × Layer Height)
//                 = 10 mm³/sec / (0.4 mm × 0.1 mm)
//                 = 250 mm/sec
// Min Print Speed = 6 mm/sec (based on "Bulge Jam" scenario)
```

Speeds: SpDefault 4800 mm/min (= 80mm/sec), *// Core profiles range 1,800–12,000 mm/min*
SpPerim 50% (@SpDefault of 4800 mm/min → 2400 mm/min = 40 mm/sec),
SpSolidIn 80% (@SpDefault of 4800 mm/min → 3840 mm/min = 64 mm/sec),
SpSupp 80% (@SpDefault of 4800 mm/min → 3840 mm/min = 64 mm/sec),
SpXY 4800 mm/min (= 80 mm/sec), *// S3D was 12000. Don't really need to go blazing around …*
SpZ 600 mm/min (= 10 mm/sec), *// S3D was 1000. Be kind to your Z axis …*
Yes AdjBelow, AdjBelowSec 15,
AdjDown 30% (@SpDefault of 4800 mm/min → 1440 mm/min = 24 mm/sec,
@SpPerim of 2400 mm/min → 720 mm/min = 12 mm/sec)

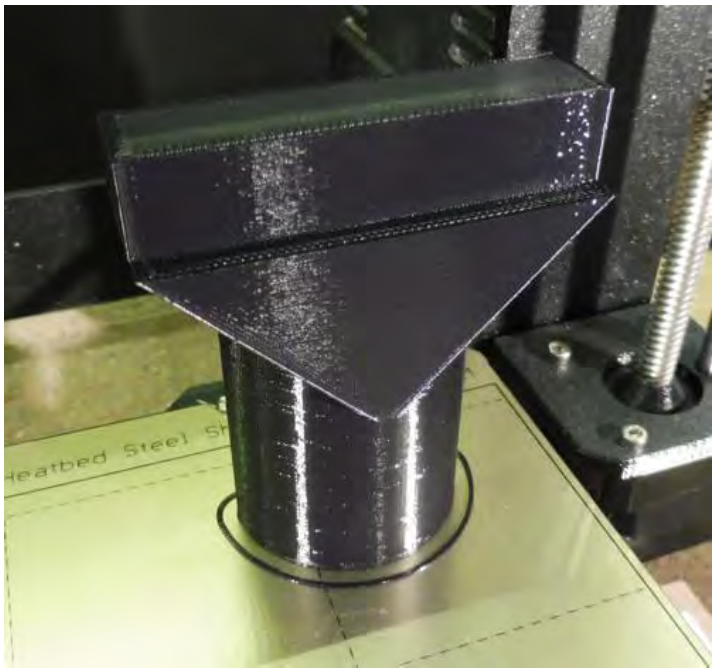
Other: Area 50,
ExInflat 1.00, *// Extra support for bridging (Warkocki & Jo Prusa profiles)*
BrExMult 100%,
BrSpMult 100% (@SpDefault of 4800 mm/min → 4800 mm/min = 80 mm/sec),
No FixedAngle 0°,
Yes BrPerim, *// This seems like a smart idea … not sure why S3D has it off*
HComp 0.00, F-List [Tool 0] FilDiam 1.75, FilPrice 46.00, FilDen 1.25,
ChgRetDist 12, ChResDist -0.50, ChRetSp 600

Advanced: No Start 0.00, No Stop 0.00,
ExThinType PerimOnly, *// Force full perimeters to be printed (S3D Default)*
InThinType AllowSingExtr, *// Allow internal fills using a variable-width single extrusion*
Overlap 40%, *// Permit more combining of infills (default is 25%)*
MinExLen 1.00, MinPWid 50%, MaxPWid 200%,
EndExtDist 0.40, *// S3D was 0.20. Naver blog suggestions "usually = nozzle size"*
Yes Open, Yes ForceRet, No MinTRetr 3.00, Yes RetWipe, Yes WipeOuter,
Yes AvoidCross, *// Seems like a good idea*
MaxDetour 5.0, *// S3D was 3.0. Jo Prusa uses 5.0*
NonManSeg Heal, No Merge

6/15/2018 Print of SandY in PLA

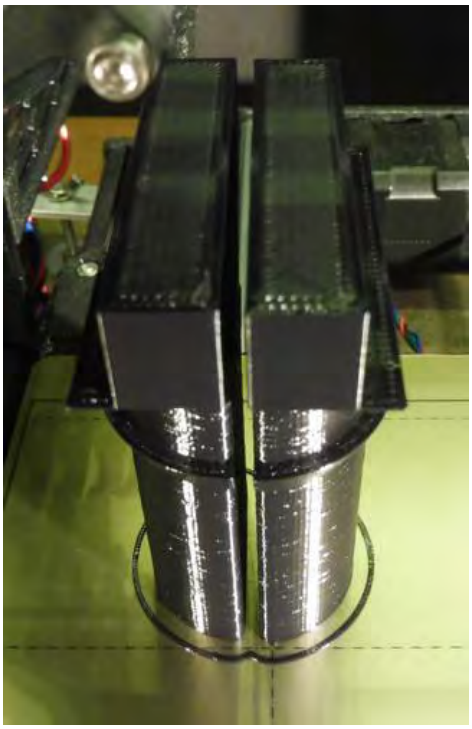
Updated SandY design printed using Rigid.Ink Black PLA. This part printed twice in slightly different locations.

- **Printed:** June 15, 2018
- **Source:** `BFlute_077.scad`
- **STL:** `BFlute_077_SY_CG_f125_20180615_1029.stl` (4.0 MB)
- **Factory:** `BFlute_077_SY_CG_f125_20180615_1029.factory`
- **Profile:** `Pi3Mk3_BFT_CG.fff`
- **Based on:** `Pi3Mk3_BFT_CG.fff`
- **G-code:** `BFlute_077_SY_CG_f125_20180615_1029.gcode` (17.6 MB)
- **Slicer:** Simplify3D 4.0.1. Profile modifications: none
- **Printer:** Pi3Mk3/CG, 0.40mm brass E3D nozzle
- **Bed Prep:** Scrubbed once with 91% IPA.
- **Filament:** Rigid.Ink Black PLA 1.75m
- **VidSetup:** (none)
- **Video:** (none)
- **Predic build time:** 1h 51m, Fil. length: 11.817 m, Plastic weight: 35.53g (0.08 lb), Cost 1.63
- **Live Tuning:** (none)
- **Actual build time:** 2h 20m
- **Printed part marked:** *(not marked)*



Results: Print worked great. Printed two.

6/15/2018 Print of Two SandS in PLA



Created SandS design and printed two copies using Rigid.Ink Black PLA.

- **Printed:** June 15, 2018
- **Source:** BFlute_077.scad
- **STL:** BFlute_077_SS_CG_f125_20180615_1754.stl (4.0 MB)
- **Factory:** BFlute_077_SS_CG_f125_20180615_1754.factory
- **Profile:** Pi3Mk3_BFT_CG.fff
- **Based on:** Pi3Mk3_BFT_CG.fff
- **G-code:** BFlute_077_SS_CG_f125_20180615_1754.gcode (6.6 MB)
- **Slicer:** Simplify3D 4.0.1. Profile modifications: none
- **Printer:** Pi3Mk3/CG, 0.40mm brass E3D nozzle
- **Bed Prep:** Scrubbed once with 91% IPA.
- **Filament:** Rigid.Ink Black PLA 1.75m
- **VidSetup:** (none)
- **Video:** (none)
- **Predic build time:** 2h 17m, Fil. length: 16.098 m, Plastic weight: 48.40g (0.11 lb), Cost 2.23
- **Live Tuning:** (none)
- **Actual build time:** 3h 8m
- **Printed part marked:** *(not marked)*

Results: Print worked great.

Sanding Tool Templates

To assist in cutting sandpaper to be useful for the Sanding Tools, I started developing Corel Draw templates on 6/15/2018 with the intent of providing it as a PDF template. Here is some initial info on that project:

- Most Sandpaper seems to be 9″ × 11″ = 228.6 × 279.4 mm = 638.71 cm².
- My HP LaserJet 475dn printer has a max media size of 8½″ × 14″ = 215.9 × 355.6 mm = 767.74 cm².
- A4 paper is 210 × 297 mm = 8.27″ × 11.69″.
- The maximum printable area of the 475dn, according to an XLS I found at https://www.edsystem.cz/ is 211.8 × 351.8 mm = 8.34″ × 13.85″ = 745.11 cm².

This means that it is unlikely that I will be able to practically print a template for a full sheet of sandpaper without wasting some border area of at least 0.66″ on the long dimension and probably 0.15″ on the short dimension.

To avoid registration and alignment issues, I am using a Corel Draw template set up for 8½″ × 11″ pages, and providing a ¼″ margin on all sides for a usable area of 8″ × 10.5″ = 203.2 × 266.7 mm = 541.93 cm². This represents a waste of 15.2% of the area of the sandpaper. Sigh.

Also, there is the issue of printing on A4 paper. If a printer imposes a margin on the 210 mm wide paper, it may not be able to print the required width of 203.2 mm that I am using in the template file.

Name Change

Changed some component names on 6/16/2018 AM:

- `SandBC` → `SandB` Bird Crown/Nest Sanding Block → Bird Sanding Block
- `SandBF` → `SandF` Bird Flue Sanding Block → Flue Sanding Block
- `SandBN` → `SandN` Body Crown/Nest Sanding Block → Nest Sanding Block
- `SandN` → `SandX` Bird Nest Rails Sanding Block (deprecated) – name changed to avoid conflict.

Path Extrude

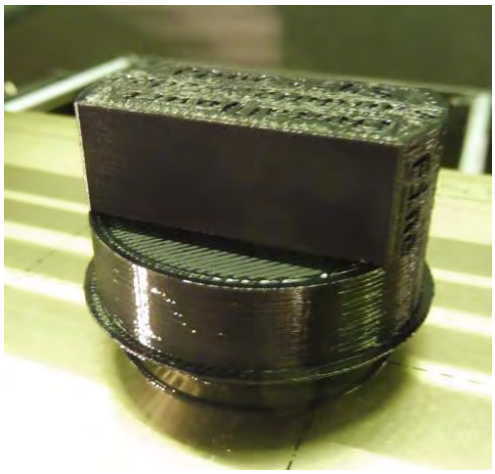
Diagnosed issues on 6/17/2018 with a number of *"PolySet has nonplanar faces. Attempting alternate construction"* errors generated by `CGAL` on an `F6` Rendering. 16 pairs of errors in the components `BodyProx`, `Headjoint`, `Body`, `BPBird`, `HeadjointHalf`, `BodyHalf`, `BodyProxHalf`, and `Lip`. Looks like the error stems from `Lip`, which would implicate `path_extrude()`.

It turns out that simply calling `path_extrude()` multiple times (`Lip()` calls `path_extrude()` twice) … causes the Nonplanar Faces error. Fixed it by duplicating the code into a second module called `path_extrude_2.scad` – a real hack!

Downloaded David's 5/28/2018 version from GitHub and tried it out, using the 2018 calling sequence. It fails badly, producing the same issues with the conflicting endpoints, and gets CGAL assertion violations. Returned to the double-code (hacked) version of the 2016 code, which works well and now has no Nonplanar Faces errors. It also seems to run much faster – the Alternate Construction code in CGAL must be substantially slower.

However … I tried a render all with the new code, and it still got 16 pairs of Nonplanar faces errors and was no faster. No idea what is happening …

6/17/2018 Print of SandQ in PLA



Created SandQ design printed using Rigid.Ink Black PLA.

- Printed: June 17, 2018
- Source: `BFlute_077.scad`
- STL: `BFlute_077_SQ_CG_f125_20180617_0603.stl` (4.4 MB)
- Factory: `BFlute_077_SQ_CG_f125_20180617_0603.factory`
- Profile: `Pi3Mk3_BFT_CG.fff`
- Based on: `Pi3Mk3_BFT_CG.fff`
- G-code: `BFlute_077_SQ_CG_f125_20180617_0603.gcode` (2.9 MB)
- Slicer: Simplify3D 4.0.1. Profile modifications: none
- Printer: Pi3Mk3/CG, 0.40mm brass E3D nozzle
- Bed Prep: Scrubbed once with 91% IPA.
- Filament: Rigid.Ink Black PLA 1.75m
- VidSetup: (none)
- Video: (none)
- Predic build time: 0h 51m, Fil. length: 6.404 m, Plastic weight: 19.26g (0.04 lb), Cost 0.89
- Live Tuning: (none)
- Actual build time: 1h 10m
- Printed part marked: *(not marked)*

Results: Printed nicely. A little rough on the top side, which makes the printing difficult to read. There is also elephant's foot, which would need to be sanded down before using as a sanding wedge.

However …

Addition of a Sanding Guide Cylinder

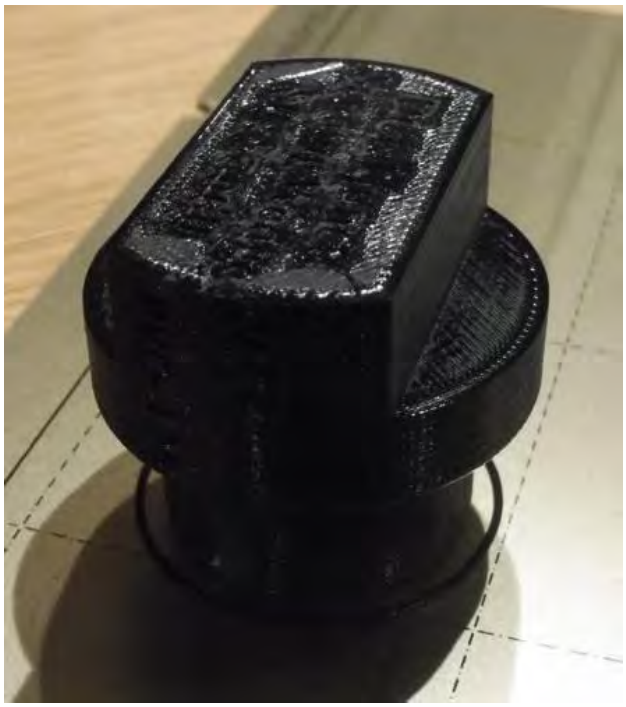
The SandQ part would not be usable as first printed, since it cannot realiably be lined up (by hand, at least) with the part it is sanding. Mis-alignment, by any amount, means an improper sand angle, which would destroy the part.

So, we add a "Guide Cylinder" below the sanding wedge of SandQ. This needs to be fairly tight to the cylinder below it.

6/17/2018 Print of SandQ in PLA

Updated `SandQ` design printed using Rigid.Ink Black PLA.

- **Printed:** June 17, 2018
- **Source:** `BFlute_077.scad`
- **STL:** `BFlute_077_SQ_CG_f125_20180617_1827.stl` (4.8 MB)
- **Factory:** `BFlute_077_SQ_CG_f125_20180617_1827.factory`
- **Profile:** `Pi3Mk3_BFT_CG.fff`
- **Based on:** `Pi3Mk3_BFT_CG.fff`
- **G-code:** `BFlute_077_SQ_CG_f125_20180617_1827.gcode` (3.7 MB)
- **Slicer:** Simplify3D 4.0.1. Profile modifications: none
- **Printer:** Pi3Mk3/CG, 0.40mm brass E3D nozzle
- **Bed Prep:** Scrubbed once with 91% IPA.
- **Filament:** Rigid.Ink Black PLA 1.75m
- **VidSetup:** (none)
- **Video:** (none)
- **Predic build time:** 1h 10m, Fil. length: 8.877 m, Plastic weight: 26.69g (0.06 lb), Cost 2.23
- **Live Tuning:** (none)
- **Actual build time:** 1h 31m
- **Printed part marked:** *(not marked)*

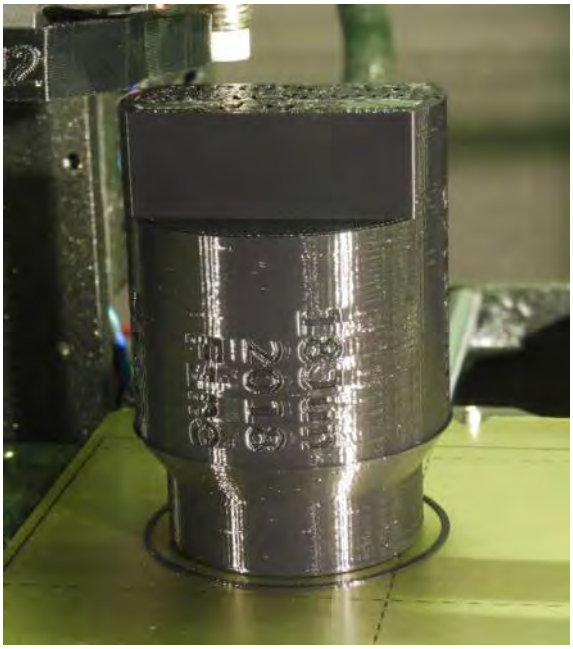


Results: Print worked great.

6/18/2018 Print of SandV in PLA

Created SandV design printed using Rigid.Ink Black PLA.

- **Printed:** June 18, 2018
- **Source:** BFlute_077.scad
- **STL:** BFlute_077_SV_CG_f125_20180618_0726.stl (7.5 MB)
- **Factory:** BFlute_077_SV_CG_f125_20180618_0726.factory
- **Profile:** Pi3Mk3_BFT_CG.fff
- **Based on:** Pi3Mk3_BFT_CG.fff
- **G-code:** BFlute_077_SV_CG_f125_20180618_0726.gcode (4.2 MB)
- **Slicer:** Simplify3D 4.0.1. Profile modifications: none
- **Printer:** Pi3Mk3/CG, 0.40mm brass E3D nozzle
- **Bed Prep:** Scrubbed once with 91% IPA.
- **Filament:** Rigid.Ink Black PLA 1.75m
- **VidSetup:** (none)
- **Video:** (none)
- **Predic build time:** 1h 31m, Fil. length: 11.319 m, Plastic weight: 34.03g (0.08 lb), Cost 1.57
- **Live Tuning:** (none)
- **Actual build time:** 1h 55m
- **Printed part marked:** *(not marked)*



Results: Print worked great.

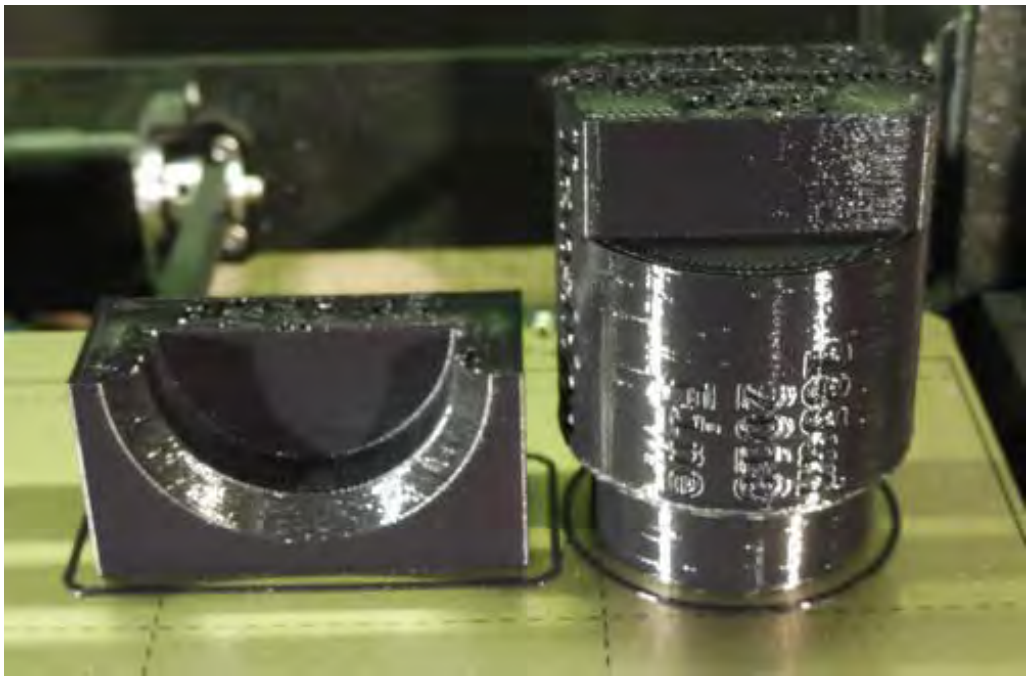
However … used the wrong angle for the Bevel … Oops!

This part was ***RENAMED*** SandT after this print!

6/18/2018 Print of SandP and SandT in PLA

Created a half-baked version of SandP that needed a test print, but the fixed and renamed version of SandT (renamed from SandV) printed using Rigid.Ink Black PLA.

- Printed: June 18, 2018
- Source: BFlute_077.scad
- STL: BFlute_077_SP and ST_CG_f125_20180618_1429.stl (1.1 and 8.1 MB)
- Factory: BFlute_077_S2_CG_f125_20180618_1429.factory
- Profile: Pi3Mk3_BFT_CG.fff
- Based on: Pi3Mk3_BFT_CG.fff
- G-code: BFlute_077_S2_CG_f125_20180618_1429.gcode (5.2 MB)
- Slicer: Simplify3D 4.0.1. Profile modifications: none
- Printer: Pi3Mk3/CG, 0.40mm brass E3D nozzle
- Bed Prep: Scrubbed once with 91% IPA.
- Filament: Rigid.Ink Black PLA 1.75m
- VidSetup: (none)
- Video: (none)
- Predic build time: 2h 4m, Fil. length: 15.115 m, Plastic weight: 45.57g (0.10 lb), Cost 2.10
- Live Tuning: (none)
- Actual build time: 2h 40m
- Printed part marked: *The SandP component is marked "1"*



Results: Print worked great.

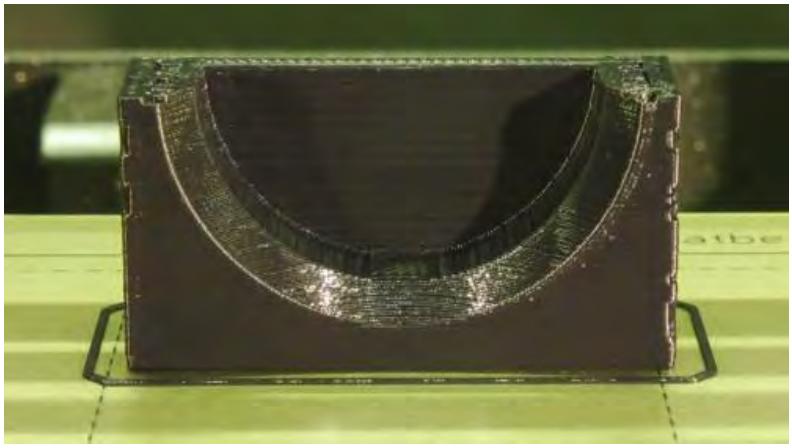
Turned out this is not suitable for the old BodyProx prints because the diameter of the bevel has changed.

NEED to check out why the bevel on SandT prints at such a high speed – is it because it is percieved as an overhang ???

6/18/2018 Print of SandP in PLA

Created a version of SandP with one bevel and a sanding bevel with a diameter that is 2mm larger. This should match the old version of the BodyProx component. Printed using Rigid.Ink Black PLA.

- Printed: June 18, 2018
- Source: BFlute_077.scad
- STL: BFlute_077_SP_CG_f125_20180618_1746.stl (2.3 MB)
- Factory: BFlute_077_SP_CG_f125_20180618_1746.factory
- Profile: Pi3Mk3_BFT_CG.fff
- Based on: Pi3Mk3_BFT_CG.fff
- G-code: BFlute_077_SP_CG_f125_20180618_1746.gcode (881 KB)
- Slicer: Simplify3D 4.0.1. Profile modifications: none
- Printer: Pi3Mk3/CG, 0.40mm brass E3D nozzle
- Bed Prep: Scrubbed once with 91% IPA.
- Filament: Rigid.Ink Black PLA 1.75m
- VidSetup: (none)
- Video: (none)
- Predic build time: 0h 36m, Fil. length: 3.258 m, Plastic weight: 9.80g (0.02 lb), Cost 0.45
- Live Tuning: (none)
- Actual build time: 0h 49m
- Printed part marked: *"2"*



Results: Print worked great.

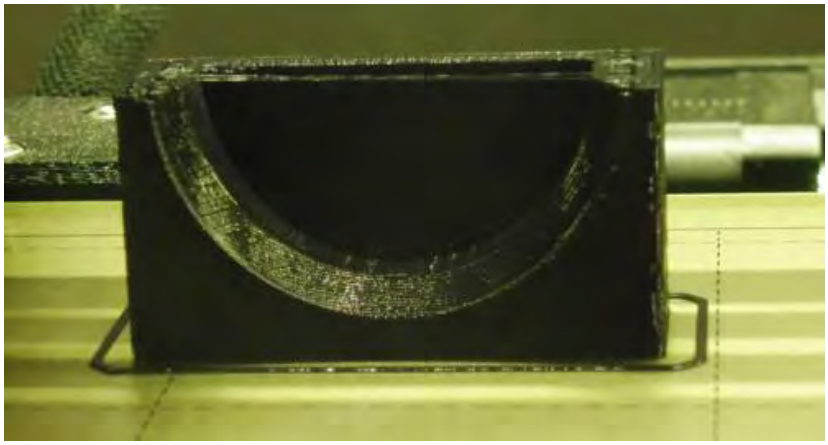
The pre-v77 prints did fit in this version, but a bit tightly and maybe not enough room for sandpaper …

6/18/2018 Print of SandP in PLA

Created a version of SandP with one bevel and a sanding bevel with a diameter that is 3mm larger. This should better match the old version of the BodyProx component. Printed using Rigid.Ink Black PLA.

- Printed: June 18, 2018
- Source: BFlute_077.scad
- STL: BFlute_077_SP_CG_f125_20180618_1913.stl (2.3 MB)
- Factory: BFlute_077_SP_CG_f125_20180618_1913.factory
- Profile: Pi3Mk3_BFT_CG.fff
- Based on: Pi3Mk3_BFT_CG.fff
- G-code: BFlute_077_SP_CG_f125_20180618_1913.gcode (849 KB)
- Slicer: Simplify3D 4.0.1. Profile modifications: none
- Printer: Pi3Mk3/CG, 0.40mm brass E3D nozzle
- Bed Prep: Scrubbed once with 91% IPA.
- Filament: Rigid.Ink Black PLA 1.75m
- VidSetup: (none)

- **Video:** (none)
- **Predic build time:** 0h 36m, Fil. length: 3.258 m, Plastic weight: 9.75g (0.02 lb), Cost 0.45
- **Live Tuning:** (none)
- **Actual build time:** 0h 49m
- **Printed part marked:** *"3"*



Results: Print worked great.

These last three prints were marked "1", "2", and "3" with a LabelMaker label and CA Glue:

Sizing of SandS and SandY

While trying to sand all the 6 viable Breath Flutes on 6/19/2018, three of them had a Mortice diameter too small for the `SandY` component.

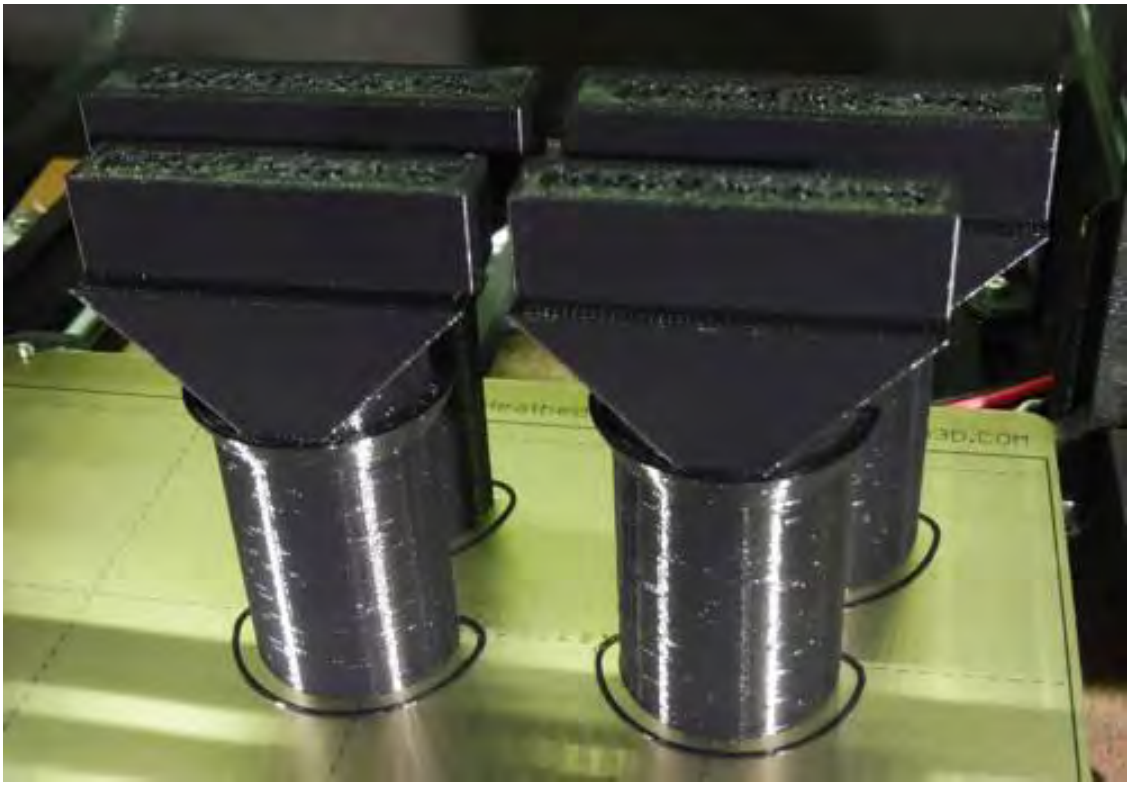
Changed the model so that the `XYExpand` parameter includes the diameter of the tube in the `SandS` and `SandY` components, and established a shrinkage factor protocol for the `XYExpand` parameter: e501–e999 represents a shrinkage factor while e000–e500 represents an expansion.

6/19/2018 Print of SandS and SandY at 98% size (XYExpand=980) in PLA

Using the newly implemented `XYExpand` that allows shirinkage factors. This should better match the old version of the `BodyProx` component. Printed using Rigid.Ink Black PLA.

- Printed: June 19, 2018
- Source: `BFlute_077.scad`
- STL: `BFlute_077_SS_CG_f125e980_20180619_1747.stl` (6.2 MB)
  `BFlute_077_SY_CG_f125e980_20180619_1747.stl` (5.2 MB)
- Factory: `BFlute_077_SS_SY_CG_f125e980_20180619_1747.factory`
- Profile: `Pi3Mk3_BFT_CG.fff`
- Based on: `Pi3Mk3_BFT_CG.fff`
- G-code: `BFlute_077_SS_SY_CG_f125e980_20180619_1747.gcode` (16.1 MB)
- Slicer: Simplify3D 4.0.1. Profile modifications: none
- Printer: Pi3Mk3/CG, 0.40mm brass E3D nozzle
- Bed Prep: Scrubbed once with 91% IPA.
- Filament: Rigid.Ink Black PLA 1.75m
- VidSetup: *(none)*
- Video: (none)
- Predic build time: 5h 27m, Fil. length: 38.252 m, Plastic weight: 115.01g (0.25 lb), Cost 5.29
- Live Tuning: (none)
- Actual build time: 7h 17m
- Printed part marked: *(none)*

Results: Print worked great!

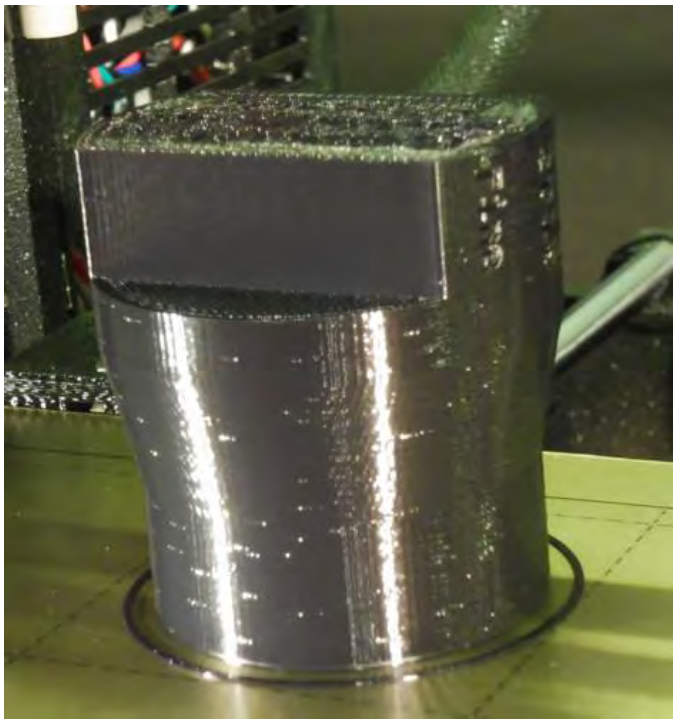


TBD: Fix the SandS and SandY so that they behave well with `XYExpand` that is smaller than 98%. They currently work at `XYExpand=980` (98%), but will fail below `XYExpand=970` (97%) because the top grip comes out below the stalk.
Done – Fixed on 6/20/2018.

6/20/2018 Print of SandZ in PLA

Print of the just-coded SandZ component using Rigid.Ink Black PLA.

- **Printed:** June 20, 2018
- **Source:** `BFlute_077.scad`
- **STL:** `BFlute_077_SZ_CG_f125_20180620_1040.stl` (5.0 MB)
- **Factory:** `BFlute_077_SZ_CG_f125_20180620_1040.factory`
- **Profile:** `Pi3Mk3_BFT_CG.fff`
- **Based on:** `Pi3Mk3_BFT_CG.fff`
- **G-code:** `BFlute_077_SZ_CG_f125_20180620_1040.gcode` (16.1 MB)
- **Slicer:** Simplify3D 4.0.1. Profile modifications: none
- **Printer:** Pi3Mk3/CG, 0.40mm brass E3D nozzle
- **Bed Prep:** Scrubbed once with 91% IPA.
- **Filament:** Rigid.Ink Black PLA 1.75m
- **VidSetup:** (none)
- **Video:** (none)
- **Predic build time:** 1h 35m, Fil. length: 12.335 m, Plastic weight: 37.09g (0.08 lb), Cost 1.71
- **Live Tuning:** (none)
- **Actual build time:** 1h 56m
- **Printed part marked:** *(none)*



Results: Print worked great.

Long Standing Issues

This is a consolidated list of all known, long-standing, pending issues that kept getting copied from one version to the next. These issues can be maintained in this one list, marked as *Done* here, and not be copied forward for each versions:

- Specialized brims that accommodate magnets?? ***TBC (to be considered)***
- What if we set it up so that the start-end points were inside the inlay channel! i.e. underneath the inlay!! ***TBD***
- May need a custom Brim for the `Bird` component, specifically to not attach the brim on the underside of the flue exit (where it would interfere with the chamfer), but attach it on all other quadrants, including the underside on the sides, where they can be filed off flat. This is problematic, because not attaching one side of the `Bird` to the brim is asking for it to fall over. ***TBD***
- Consider a sanding tool for the front lip of the bird – to restore the chamfer after removing the brim. ***TBC***
- Consider providing a raised plate ("platform", "dais"?) for the "Breath Flute" inscription on the `BodyDist` component. The platform would facilitate filling-and-sanding (Woodfill? Sculpt Wood? Engraving Filler Stick / Putty?) The platform could both raise at the edges and cut into the circumference of the `Headjoint`. Four separate platforms, two on the TSH cylinder area and two on the Flare. ***TBC***
- Locate engraver's filler to fill in the Breath Flute logo – Stew Maclen Laskin engraving filler? Bowling Ball engraver filler? Markforged Engraver Filler labelling article? ***TBD***
- Consider printing the logo in Reverse in a different color and snapping it in. Is this feasible?? Too finicky?? ***TBC***
- Smooth out the transition from the ramp to the flue with an "eased" / curved transition. This involves the center curved section and the side straight sections. ***TBD***
- Add Bolt Holes and Nut Slots to the bottom of `SandB` and `SandC` (and other components?) to allow them to be bolted down. ***TBD***
- Experiment with how the OpenSCAD model behaves when you change pipe sizes. ***TBD***
- Add a factor to scale the tenon at the foot of the `BodyProx` component slightly smaller, so that it fits nicely into the `BodyDist` component. *Done – 6/28/2018. After sanding the fourth Breath Flute (the first nGen print that was viable) for about an hour to get the BodyProx to fit into the BodyDist without cracking it (almost did – actually heard one small "ping" but could not locate a crack), I came back and implemented the* `BodyProxTenonFactor`. *It is internal to the code only – no external switch.*
- Add a parameter / option on the model for Bolted vs Tied bird? *Done – 6/25/2018 – implemented the new BirdStyle option with choices of Tied, Peg, and Wedge.*
- Develop a separate module for Standard Polygons – rectangular, Pentangular Prism, etc. Needs to have an integrated or associated diagram facility to be useful. ***TBC***

- Add flat faces on the sides of the Nest – to give it a less rounded, more angular look that echoes the distal end of the Bird. Probably should not affect the sliced Bird component. ***TBC***
- Consider a "Z" or "S" type of back to the Sanding Dowel components so that they mate with each other and form a more positive lock versus just aligning them. The "S" curve would be the same on both pairs of components. Downside is that the sandwiching of the end of the strip of sandpaper becomes a bit more problemantic. ***TBC***
- Develop the new SandG component – the Sanding Grip to protect the Grip at the bottom of Sanding Dowels in the jaws of a vice grip. This component is designed to crush before the Grip crushes, if too much force is applied to the vice grip. ***TBC***
- Alcohol testing on the nGen cube. ***TBD***
- A potential issue involves the distal face of the `Bird` component. The `Bird` cannot be printed with a brim, because the brim masks the (fairly subtle) chamfer on the bottom of the distal end of the `Bird`. The brim is also difficult to remove. However, with the distal face of the `Bird` perpendicular to the longitudinal axis of the flute, the `Bird` component is actually canted and somewhat top-heavy. This could spell disaster, if the (rather small) distal face of the `Bird` is not stuck tightly to the print bed. One solution would be to cant the distal face of the `Bird` (slightly) to allow the component to print more vertically. However, that face angle is a design parameter (although it is currently defaulting to a generic 90°), and this solution would fix that parameter at a certain value. ***TBD***
- Improve mounting of GoPro Camera so that it is more forward and lower. Using an aluminum rod extension will allow this. Issues involve angle of view (needs to be lower) and focal length – which needs to be at least 8–12″. ***TBD***
- (from v72) Create a new Inset Splicer tool (`InSplice`) to precisely cut the angles for insets on the sides of the flute body. This could be done as an external model, rather than in the every-ballooning `BFlute.scad` file. ***TBD***
- Consider setting a given angle for the inflection point on the Bird and the Nest, and calculate the polygon for carving the Bird off of the Headjoint from that angle. We currently have hardwired "points in space" and back-calculate that Nest Inflection Angle, report it, and then use it for things like creating sanding tools. However … this change would necessitate printing new `SandB` and `SandN` tools. ***TBC***
- If we are primarily using a tied-on `BirdStyle`, can we get rid of the built-up nest (that was primarily used to support the Bird Pegs)? ***TBC***

Breath Flute #78 – Improvements Beginning 6/22/2018

The issues addressed in this version …

- Develop sanding "dowels" for the various bore sizes – two half-cylinders that can be combined with a spacer (bond paper) to keep enlarging them – or maybe even foam of various thicknesses – something springy! *Done – SandY and SandS components.*
- Develop cone-shaped tenon sanding wedges (or "cones") for the bevel on the tenon of the `BodyDist` component and the diameter-transition bevel on the inside of the sound chamber bore. *Done – SandQ component.*
- Develop inverse-cone sanding wedges for the bevel at the base of the Junction of the `BodyProx` component. *Done – SandP component.*
- Develop CDR-based templates (delivered as PDFs) for the outline of the sandpaper to cut for the cone-shaped sanding wedges. See the `/HowTo` articles on Cone Templates as well as the XLS from the FoamConeSander article. *Done – A fully developed Corel Draw template and associated PDF file has been developed.*
- Add a MicroBevel to all Sanding Tools to counteract elephant's feet. *Done – 6/24/2018.*
- Undertake destructive testing on the useless sandinging tools that were printed – where do they fail? *TBD*
- Consider a new Sanding Tool for the outside of the distal end of `BodyDist` – to make trimming off any brim more reliable on the rounded circumfrance of the foot. It's pretty clear a brim is going to be needed after the first attempted print below … *Done – 6/27/2018 – implemented the new SandV component, but when changing filament from nGen Lux back to PLA, I broke off the old filament, then got it jammed down the PTFE tube, requiring Prusa support, Prusa Forum support, a DHL shipment of a new PTFE tube, and significant michegas.*
- Implement a `ComponentClass` variable based on the groupings of components. Use it to reduce the amount of `echo()` reporting during rendering. *Done – 7/1/2018*
- Automatically set the `cFlag` (renamed to `ComponentFlag`) in both render.bat and the OpenSCAD model based on the setting of the `Component` parameter. The by-hand setting of these in tandem is annoying and error-prone. *Done – 7/1/2018*
- Set the `XYExpand` Parameter for JunctionDist – it is printed on the side. *Done – 7/1/2018*
- There is a 0.01 mm variability on the base of the `BodyProx` and related component, undoubtedly having to do with unfortunate uses of `Smidge`. Fix it! *Done – 7/2/2018. This called for modifications to the code in 3 places to remove or add the use of* `Smidge`*. The three locations are marked with the string "7/2/2018 Smidge Adjustment" so they can be found.*
- Add the `BirdStyle` parameter to the `JunctionProx` and `PG` componenets. *Done – 7/1/2018*
- Expand the Developer's Guide to show exactly what flavors of each component are rendered in the distribution package. *Done – 7/1/2018*

- There is no printing at all on the `JunctionProx` and `PG` componenets … add some! *Done – 7/2/2018. Added extensive inscriptions to both components, as well as the JunctionDist component.*
- Add a `Scope` parameter to render.bat to reduce the number of rendered components. `Scope=Dev` renders 8 components. `Scope=All` renders all the components needed for a distribution package (current 82!). *Done – 7/2/2018*
- Expand the printing on the `Foot` component, and regularize it to use the common inscription routine for polar coordinates, rather than custom code. *Done – 7/1/2018*
- Add drain holes to the `BodyHalf` and `Body` components. *Done – 7/1/2018*
- If a part has no Bird Peg holes (frequent, since changing to `BirdStyle=Tied` as the default), why do we have the Backing Box behind the flue?? *Fixed – 7/3/2018 – restored the FlueWall version of the floor of the flue as an alternate to the Flue Backing Box.*
- `BodyHalf` needs a `BirdStyle` parameter. *Done – 7/1/2018*
- There is an issue with printing on the Foot component: the lettering is angled down at about 9.4° (actually half that … reporting had a bug) from vertical (the reported "Shell angle" for `MorticeB` now echoed on the output of some components). This angled-down printing will invariably cause some free-standing "islands" of "printing in space" – completely unsupported. What if we used the Flare parameter?? *TBD*
- The `BodyProx` component with `BirdStyle` "`T`" still has peg holes! *Fixed – 7/3/2018*
- Change the parameter / variant `Imprint` to `FabricatorCode`. *Done – 7/3/2018*
- The `BodyDist` component with Inlays has an odd wedge-shaped piece at the distal end of the inlays. *Done – 7/3/2018*
- The changes to flatten the flue in order to keep the entire flue floor below the nest rails have caused the `SandF` component to the wrong shape. This work involves the "Differential Flue Radius", implemented on 6/8–12/2018. The change is significant and noticable … new calcs will be needed for `SandF`! *TBD – this turned into a major hairy hairball … see "The SandF Dislocation Episode" documented below.*
- Change name of `BirdPegs` component to Throat. This is because `BirdPegs` is currently printed for `BirdStyle` settings that have no Bird Pegs! *Done – 7/4/2018*

6/24/2018 Print of BI, BP, BD in nGen Lux

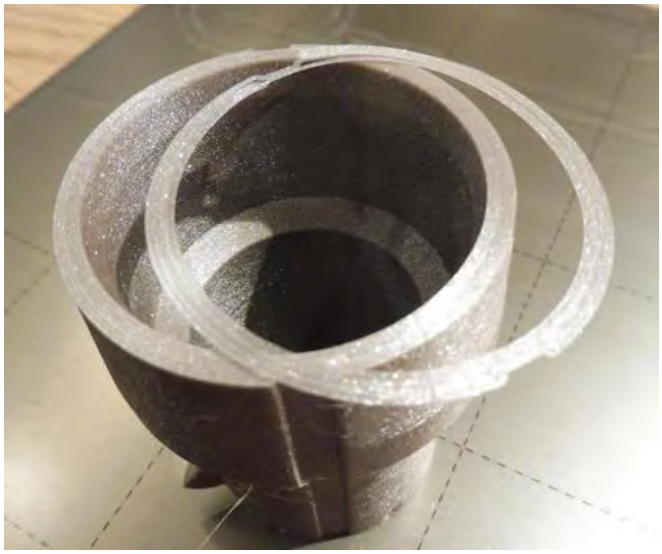
Four G-code files generated: `BodyDist` and `Bird` (`_BIBD_`) and `BodyProx` (`_BP_`), with and without brims. Printed in nGen Lux.

- **Printed:** June 24, 2018
- **Source:** `BFlute_078.scad`
- **STL:** `BFlute_078_BI_CG_f125L_20180623_0805.stl` (4.9 MB)
  `BFlute_078_BP_CG_f125Li3_20180623_0805.stl` (11.3 MB)
  `BFlute_078_BD_CG_f125i3z5e010_20180623_0805.stl` (6.1 MB)
- **Factory:** `BFlute_078_BIBD_CG_f125L_20180623_0805.factory`
  `BFlute_078_BP_CG_f125Li3_20180623_0805.factory`
  `BFlute_078_BrimBIBD_CG_f125L_20180623_0805.factory`
  `BFlute_078_BrimBP_CG_f125Li3_20180623_0805.factory`
- **Profile:** `Pi3Mk3_BF_CG_nGen.fff / Pi3Mk3_BF_CG_nGen_Brim16.fff`
- **Based on:** `Pi3Mk3_BF_CG_nGen.fff`
- **G-code:** `BFlute_078_BIBD_CG_f125L_20180623_0805.gcode` (24.4 MB)
  `BFlute_078_BP_CG_f125Li3_20180623_0805.gcode` (21.0 MB)
  `BFlute_078_BrimBIBD_CG_f125L_20180623_0805.gcode` (25.3 MB)
  `BFlute_078_BrimBP_CG_f125Li3_20180623_0805.gcode` (21.1 MB)
- **Slicer:** Simplify3D 4.0.1. Profile modifications: none
- **Printer:** Pi3Mk3/CG, 0.40mm brass E3D nozzle
- **Bed Prep:** Cold Prusa PEI SSS. Warm water good scrub with paper towels. IPA 91% – good scrub with paper towels. 3DLAC, shake can and apply a thin spray from 1 foot above the bed on the front right corner of the bed.
- **Filament:** ColorFabb nGen Lux Champagne Gold 1.75m
- **VidSetup:** (none)
- **Video:** (none)
- **Predic build time:** BIBD: 6h 53m, Fil. length: 19.819 m, Plastic weight: 59.59g (0.08 lb), Cost 2.74
  BP: 5h 33m, Fil. length: 15.813 m, Plastic weight: 47.55g (0.10 lb), Cost 2.19
- **Live Tuning:** Extensive – see below
- **Actual build time:** 8h 21m (print cancelled)
- **Printed part marked:** *(none)*

Printed the brim-less `BodyDist` and `Bird`. At some point above where the `Bird` completed, at about Z=58.45 – about 87% of the Gcode on the SD card – the `BodyDist` had clearly become largely unstuck from the bed. It was rocking and could be heard to knock, although there was no apparent damage to the part. It seemed that the speed of the bed moving band and forth was causing it to tip and plunk back down.

In a bid to save the BodyDist component, I live-tuned the speed to 50%, and the problem seemed to abate, mostly. There was still a bit of knocking. I soon went to 40% print speed. I then raised the bed temp from 65°C to 75°C (some ill-founded idea that the foot of the print might melt or at least stick at a higher temperature).

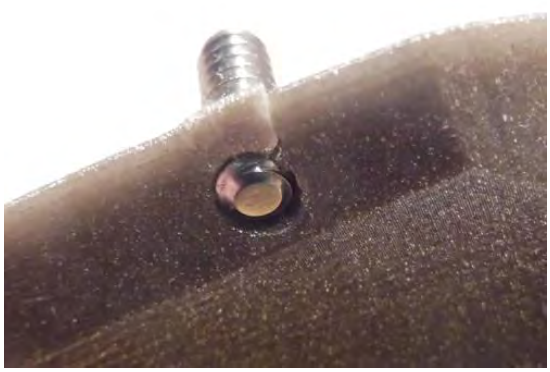
However … the BodyDist component kept getting more and more unstuck, and eventually moved, jammed against the print head, which stopped, homed itself, and then tried to go back to printing with the BodyDist already dislodged. I cancelled the print.



It does seem that the Bird was was well stuck to the bed, even without a Brim. However, the BodyDist was not. A major culprit does seem to be the speed of motions during non-extruding transitions (which Live Tuning for Speed does ***not*** seem to affect!)

> One more thing … The bottom printed layer of the BodyDist component de-laminated from the print after it was removed from the print bed. No idea why.

End result: Got a Bird out of this print (and some learning experiences).



And, finally, when I screwed in one of the new 6-32 set screws, the edge of the Bird cracked. There is simply no way it will ever be strong enough to hold a set screw in its current configuration. Two options:

1. Beef up the Bird with a collar around each peg hole to avert cracking, or

2. Remove the portion of the Bird that is outboard of each of the peg holes. The set screws would hold the Bird in position by pressure pushing in towards the center. Note that the set screws would then be exposed from the outside – maybe not so pretty. The "cutout" for this "strain relief" approach would need to be V shaped, so that there is no overhang situation while printing the Bird vertically.

Maybe consider option 2.

6/24/2018 Print of BodyProx and BodyDist in nGen Lux

- **Printed:** June 24, 2018
- **Source:** `BFlute_078.scad`
- **STL:** `BFlute_078_BP_CG_f125Li3_20180623_0805.stl` (11.3 MB)
  `BFlute_078_BD_CG_f125i3z5e010_20180623_0805.stl` (6.1 MB)
- **Factory:** `BFlute_078_BPBD_CG_f125L_20180623_0805.factory`
- **Profile:** `Pi3Mk3_BF_CG_nGen_Brim16.fff`
- **Based on:** `Pi3Mk3_BF_CG_nGen.fff`
- **G-code:** `BFlute_078_BPBD_CG_f125L_20180623_0805.gcode` (42.5 MB)
- **Slicer:** Simplify3D 4.0.1. Profile modifications: none
- **Printer:** Pi3Mk3/CG, 0.40mm brass E3D nozzle
- **Bed Prep:** Swept off the prior print with a plastic spatula. No other treatment of the print bed.
- **Filament:** ColorFabb nGen Lux Champagne Gold 1.75m
- **VidSetup:** (none)
- **Video:** (none)
- **Predic build time:** 11h 15m, Fil. length: 32.144 m, Plastic weight: 96.64g (0.21 lb), Cost 4.45
- **Live Tuning:** (none)
- **Actual build time:** 13h 11m
- **Printed part marked:** *(none)*

Results: Great!

6/25/2018 Print of Two New BirdStyle variants of the Bird Component in nGen Lux

- Printed: June 25, 2018
- Source: `BFlute_078.scad`
- STL: `BFlute_078_BI_CG_f125LbW_20180625_1037.stl` (4.6 MB)
  `BFlute_078_BI_CG_f125LbT_20180625_1037.stl` (4.7 MB)
- Factory: `BFlute_078_BI2_CG_f125LbT_20180625_1037.factory`
- Profile: `Pi3Mk3_BF_CG_nGen.fff`
- Based on: `Pi3Mk3_BF_CG_nGen.fff`
- G-code: `BFlute_078_BI2_CG_f125LbT_20180625_1037.gcode` (??.5 MB)
- Slicer: Simplify3D 4.0.1. Profile modifications: none
- Printer: Pi3Mk3/CG, 0.40mm brass E3D nozzle
- Bed Prep: Swept off the prior print with a plastic spatula. No other treatment of the print bed.
- Filament: ColorFabb nGen Lux Champagne Gold 1.75m
- VidSetup: (none)
- Video: (none)
- Predic build time: 2h 38m, Fil. length: 7.034 m, Plastic weight: 21.15g (0.05 lb), Cost 0.97
- Live Tuning: (none)
- Actual build time: 3h 4m
- Printed part marked: *(none)*

Results: Printed well without brims.

6/27/2018 – Broken Filament / Filament Jam in the HotEnd PTFE Tube

Change of filament from the Gold-colored nGen Lux to the Black rigid.Ink PLA. The nGen felt like it "broke off" on extraction, and the PLA refused to load ("Click, click, click, …").

See https://shop.prusa3d.com/forum/hardware-firmware-and-software-help-f64/broken-filament-in-extruder-%E2%80%93-please-advise-t19747.html for the Prusa Forum version of this litany. Additional information is in `/HowTo_Articles/Prusa_PFTE_Tube`.

While changing filament on my MK3, the old (Gold-colored) filament felt like it broke as I pulled it out. Sure enough, the new (Black-colored) filament would not load ("Click, click, click, …").

I opened the Extruder idler door and took this picture below. New, black filament is poised above. Old, gold filament appears to be just below the lip of the PFTE tube.

The lip of the PFTE tube also seems to be damaged. There also appears to be other issues in this area – deformed black PETG to the left of the PFTE tube, and maybe caked something on the metal gear itself (clear PFTE??).

Chat Support 7AM 6/27

Marina: Please try to heat up the hotend for PETG for about 5 minutes, and then try loading the filament again. It is beeter to do this with the filament sensor off

Clint Goss: OK, I can try that ... the old (gold) filament is nGen - maybe 220-230 normal print temp. What temp would you advise for the 5 minute heat-up?

Marina: You can use 240°C

Clint Goss: OK ... and how to load ... disable autoload and use Settings -> Move Axis -> E axis to load by hand?

Marina: Yes, that is correct

Clint Goss: OK Thanks ... I'll get on that! ; heating now ... ; No luck. Still clicking. ; 7:15 am I am not sure that the new black filament is even point straight down the pfte tube, because of the deformation of that tube ... 7:19 am Any other ideas? 7:21 am Been at 240 for 12 minutes now ... still stuck ... is it a problem keeping it this hot and not moving filament for this long?

Marina: Please check the tension screws. They are the long ones below the extruder gear. Their bottom ***should be around 1 mm below the printed part***

Clint Goss: Tension screws are good - aligned with the body. I am also pressing down with my hand on the filament from the top ...

Marina: I can send you a new PTFE tube, if you do not mind chsnging it yourself

Clint Goss: never did it, but I can figure it out ...

More info: I did manage to push the new filament down about half way from the gear to the nozzle. Then it got stuck again. The new filament got as far down as the center of the part-cooling fan, which is about mid-way in the heat sink. What would make it get stuck that far down? I was also able to run an Acu needle up the nozzle to this same point. Now I am rally not sure what is wrong here ...

Marina: I have made a replacement request for the PTFE tube. You should be able to fix the problem with it. You can check this video for instructions while we do't have an official one: https://www.youtube.…m/watch?v=LdLTt-TjeQk&t=4s

Clint Goss: 7:47 am OK, thank you ... would you know why the filament is jamming half way down the heatsink? Maybe it is related to a damaged PFTE tube??

Marina: Yes, that is the most likely

Clint Goss: OK ... thank you ... could you guess how long till I receive a new PFTE tube? Just any guess would be helpful ...

Marina: It should reach you in 2-5 business days

Clint Goss: Thank you **SO MUCH**

Marina: 7:52 am You're welcome :-)

Prusa Forum Advice

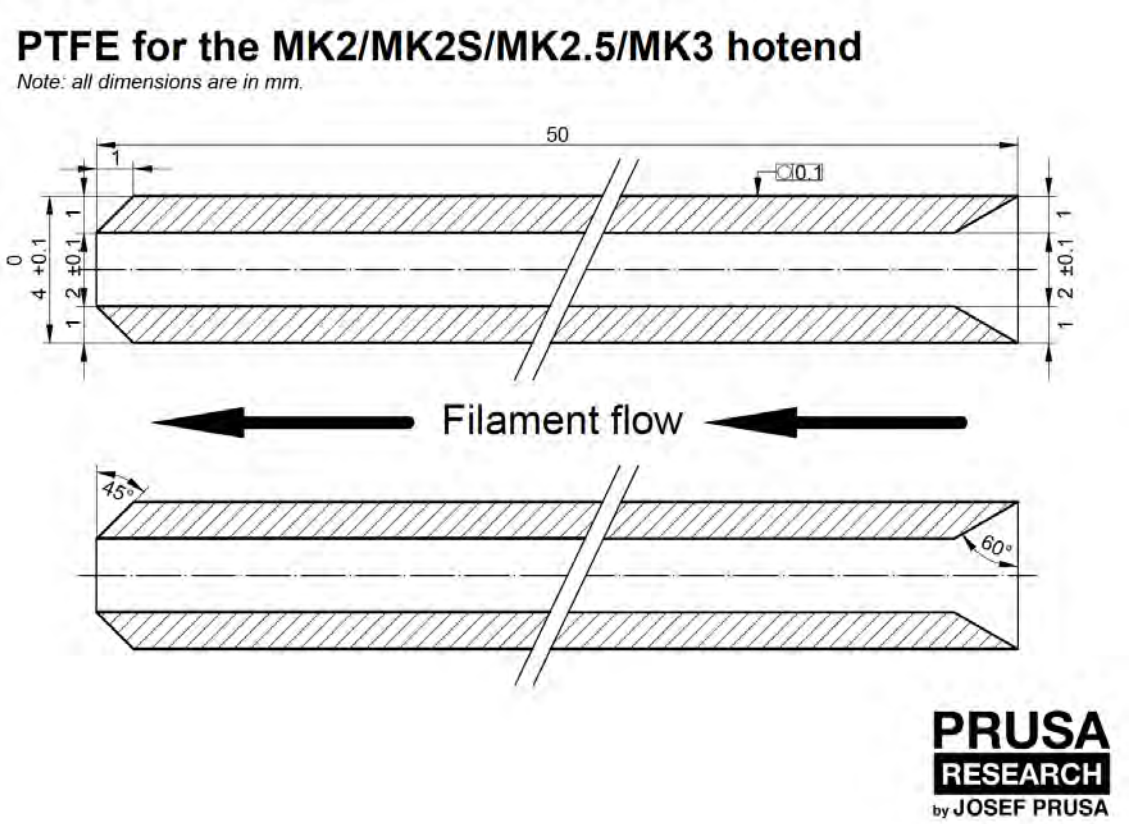
Various resources and advices from members of the Prusa Forum:

Joan: you could consider heating the hot end, removing the nozzle and trying to push the filament up into the Bondtech chamber, with a stiff piece of wire. but this is likely to damage the PTFE, if that's not already damaged...

have a look at the last post in this thread: https://shop.prusa3d.com/forum/assembly-and-first-prints-troubleshooting-f62/-extruder-jammed-can-t-unload-filament-click-sound-t19161.html#p91476

the PTFE needs shaping as in the diagram here https://help.prusa3d.com/l/en/article/nt3gmt736i-ptfe-tubes-in-original-prusa-i-3-printers.

The second link above provides this engineering diagram for the Mk3 HotEnd PTFE tube:



Rod Clearing Method

Advice from Forum user Bobstro:

> Remove the nozzle, straighten out a 1.5mm diameter hex key, and manually push the stuck filament up from the bottom to pop it out into the extruder gear drive (BondTech) chamber.

I found a spare Allan wrench that seemed to fit the bill - 1.54mm from face to face and 1.72mm at its widest (point to point). Tried to straighten it out, but it cracked (strong but brittle, I guess). However, I still had a length of 76 mm to work with. It seems to be about 78 mm from the bottom of the heat block to the top of the PTFE tube, and 112 mm total from the bottom of the heat block to the top of the extruder where the filament enters.

I heated to 230C, removed the nozzle, and pushed up from the heat block with the Allan wrench rod. A firm and defiant blockage, 27 mm from the bottom (heat block), and I was really pushing alarmingly hard. I tried with filament from the top end and the blockage was hit 82 mm from the top of the extruder where the filament enters. The math says the blockage is about 3mm high, and appears to be 1/3 of the way up the heat sink.

Extrude Before Unloading

More advice from user Bobstro:

> Once you are back up and running, always extrude 20-25mm and then immediately unload. This gets rid of the melty mess and makes unloading easy. This is a common problem if you preheat, wait, and then unload. Extrude first and immediately unload.

Never seen this advice. Not sure why. Pretty basic ... like every printer should arrive with a big, bright, bold plaque announcing ...

Extrude Before Unloading ... or you'll be sorry ...

I do (now) see on Github (https://github.com/prusa3d/Prusa-Firmware/issues/417) the calls for this to be added as standard practice ... Oh, this is such a young technology ...

Forum user chris.n6:

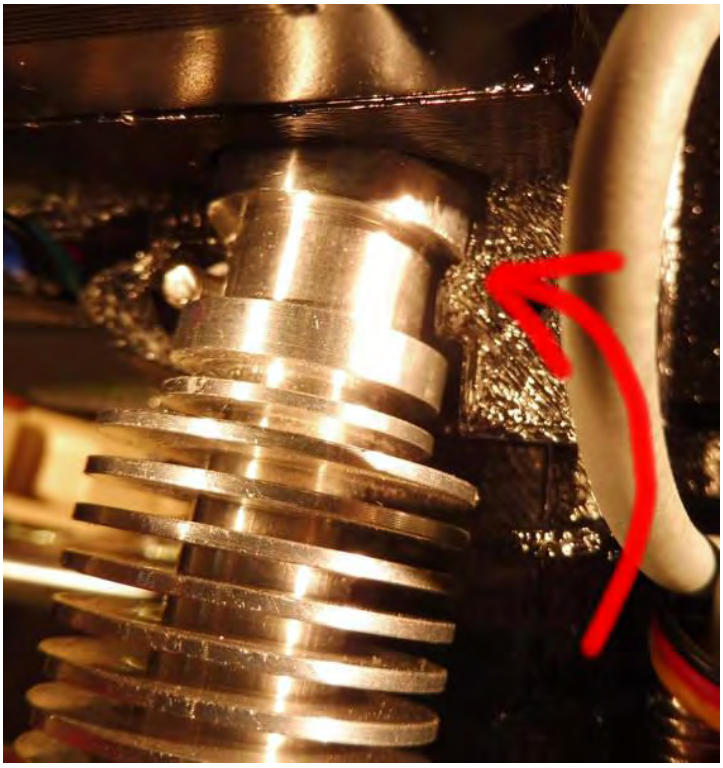
> yeah i am cnlson over on git. so you can see me begging marek to add it so far unsuccessfully. i do it each time. Started when someone ripped the sensor off their filament sensor board and i had nearly the same experience.

Summary of Resources

Here is a list of all related resources, of various applicability and usefulness:

- https://shop.prusa3d.com/forum/assembly-and-first-prints-troubleshooting-f62/-extruder-jammed-can-t-unload-filament-click-sound-t19161.html#p91476
- https://help.prusa3d.com/l/en/article/nt3gmt736i-ptfe-tubes-in-original-prusa-i-3-printers
- https://manual.prusa3d.com/Guide/How+to+trim+PTFE+tube+-+MK2-S+MK2.5+and+MK3/500?lang=en
- https://www.matterhackers.com/articles/how-to-assemble-an-e3d-v6-all-metal-hotend
- https://e3d-online.dozuki.com/Guide/V6+Assembly/6?lang=en
- https://www.youtube.com/watch?v=jmmfh2An5Mc
- https://manual.prusa3d.com/Guide/5.+E-axis+assembly/510?lang=en
- https://www.youtube.com/watch?v=LdLTt-TjeQk&t=4s
- https://manual.prusa3d.com/Guide/How+to+replace+PTFE+tube/82
- https://www.youtube.com/watch?v=Uv_v5-wtHaE&feature=youtu.be

HeatSink Removal



Had problems removing the HeatSink from the Extruder:

Cut all the ZIP ties and unwrapped the black spiral cable organizer to get wire slack to remove the HeatSink + HeatBlock. Could not pull them out, and it looked like the deformed top of the PTFE was blocking extraction, so I surgically snipped off ever more chunks of PTFE and removed them. Then I realized there is actually a tab on the printed part that forms the back of the HeatSink enclosure.

Not sure what to do now. Arrow shows the TAB that seems to block extraction.

There seems to be no way to pry the HeatSink forward enough to clear the TAB. I can't even imagine how I would re-install the HeatSink (if I ever do get this repaired).

Eventually found this video at https://www.youtube.com/watch?v=Uv_v5-wtHaE&feature=youtu.be, which demonstrates how to pry the HeatSink from the plastic housing on the Extruder. I had to use some serious prying. You basically pry down (negative Z) for a bit until the HeatSink collar clears the plastic, then forward (negative Y) to clear the tab (the one pointed to by the arrow in my post above).

Reassembly

Prusa Chat Support:

Clint: I have a 50 mm long PTFE tube from your shop, cut for the Mk3. I have a HeatSink and a HeatBreak screwed together. Do I simply insert the unmodified PTFE tube into the HeatSink, until it hits the HeatBreak … and then I am set?

Peter 12:32 pm Yes, if you have the HeatSink + HeatBreak together, then just insert the PTFE inside it.

Clint Goss OK ... thank you ... to confirm: I do *not* trim it square (some source specify that step, some do not). I should insert it so that the 45 degree V mates with the HeatBreak, is that correct?

Peter 12:39:09 pm Yes, correct

Success

The culprit is shown here – a clog firmly jammed in what is probably a slight bulge in the PTFE tube, probably created by repeatedly ignoring the ultra-important, super-secret mantra:

Extrude Before Unloading

6/29/2018 Re-Calibration

After the PTFE tube replacement, these steps were done:

AutoHome

Z reads 0.15

Measured nozzle and PINDA height similar to 4/2/2018 method, using feeler gauges made of 24lb Staples printer paper. (24lb / 60lb offset text (uncoated) paper and 80lb gloss text coated paper at 0.004″ = 4 mil = 0.01016 cm = 0.1016 mm per sheet)

Height of Nozzle: 10 paper sheets (quite snug tight) = 1.02 mm

Height of PINDA: 18 paper sheets (nicely snug) = 1.83 mm

Difference: 8 paper sheets or 0.81 mm – same as before!

Lowering Z to 0:

Height of Nozzle: 8 paper sheets (snug) = 0.81 mm

Height of PINDA: 17 paper sheets (very very snug) = 1.73 mm

Difference: 9 paper sheets or 0.92 mm

Self Test

Self test done with NO Spring Steel Sheet. All OK.

Calibrate XYZ

Calibrate XYZ with no SSS, paper below the extruder

"XYZ calibration OK. X/Y axes are perpendicular. Congratulations!"

Support → XYZ Calibration details:

- Y dist from min
- Left: 10.71 (was 10.65 after Rock Bottom development; was 10.75 initially)

- Right: 10.85 (was 10.84 after Rock Bottom development; was 10.86 initially)
- Measured Skew: 0.05° (was 0.03° after Rock Bottom development; (was 0.06° initially)

Calibrate Z

Calibrate Z: Runs Z to the extreme top, then does a 9-point calibration. Completes

Mesh Bed Leveling

Mesh Bed Leveling "Calibration Done"

First Layer Calibration

Prints a calibration pattern followed by a 200um thick square. Based on examining that square, the setting for Live Z:

- –0.515mm: clearly too high
- –0.725mm: seems good, Maybe now a tad too low. Layer thickness of printed square measures 0.22 mm.

Rods

Wondering whether something like this might be a useful tool for potential future PTFE clogs. These are 1.5 mm, 100 mm long. They are available is Brass and Stainless Steel. Common parts for RC car axels and airplanes.

I'm thinking they may be better than a hex Allan wrench. No chance of damage from angular corners, and they are longer.

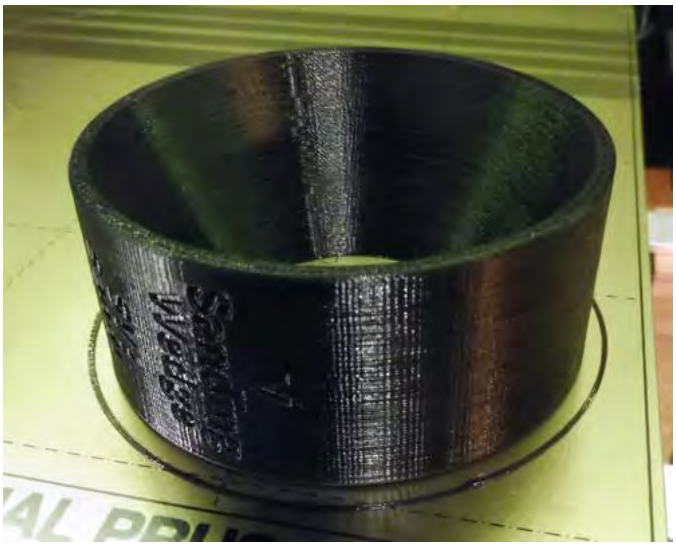
Maybe better than a then 100 mm long version would easily reach (by my calcs) from the heatblock up to the extruder gear chamber (that's the "BondTech chamber", yes).

Here's a question: with the extruder idler door open, would it be possible to use this from the *top* of the extruder and get it past the gears into the PTFE tube? i.e. would the drive gear alone with no idler gear inhibit / deflect travel of a straight rod?

6/27–30/2018 Print of new SandV in PLA

Print of the just-coded SandV component using Rigid.Ink Black PLA. The filament jam in the PTFE tube, detailed above, happened on the morning of 6/27/2018. After the repair, the print was done in the evening of 6/30/2018.

- **Printed:** June 27–30, 2018
- **Source:** `BFlute_078.scad`
- **STL:** `BFlute_078_SV_CG_f125_20180627_0544.stl` (7.3 MB)
- **Factory:** `BFlute_078_SV_CG_f125_20180627_0544.factory`
- **Profile:** `Pi3Mk3_BFT_CG.fff`
- **Based on:** `Pi3Mk3_BFT_CG.fff`
- **G-code:** `BFlute_078_SV_CG_f125_20180627_0544.gcode` (11.9 MB)
- **Slicer:** Simplify3D 4.0.1. Profile modifications: none
- **Printer:** Pi3Mk3/CG, 0.40mm brass E3D nozzle
- **Bed Prep:** Cleaned with warm water twice to remove the 3DLAC. Scrubbed twice with 91% IPA.
- **Filament:** Rigid.Ink Black PLA 1.75m
- **VidSetup:** (none)
- **Video:** (none)
- **Predic build time:** 2h 43m, Fil. length: 11.970 m, Plastic weight: 35.99g (0.08 lb), Cost 1.66
- **Live Tuning:** (none)
- **Actual build time:** 3h 19m
- **Cum. print time:** 19d 8h 7m = 464.1 hours
- **Cum. filament:** 528.53 m
- **Printed part marked:** *(none)*



Results: Print worked great.

Post-Processing of the first 7 Viable Headjoints – the "Gang of Seven"

Undertook completing as many of the existing, usable Breath Flutes as possible, to gain experience, have a demo flute for the WFS convention, and have one I can give to Jon. This was done in the 6/24/2018 – 7/4/2018 timeframe. Here is a summary of the completed flutes, in order of the date they were rendered / printed (the color of the paragraph leader tracks the color of the flute).

Note that this work ended in the ***SandF Dislocation Episode***, documented in the section below, and led to plans for significant modifications to the overall Breath Flute design.

Unless otherwise noted, all prints use 0.40 mm E3D v6 nozzle and a 100µm layer height. The flutes from left to right, in the order of the version and date they were printed:

CorkFill One-Piece Body. A v61 flute rendered and printed on 7/4/2017 (almost a year ago!). It was printed on the FCMG Ultimaker 2+ in 2.85 mm Brown ColorFabb Corkfill, 100µm layers, 30% infill @ 2500 mm/min with a four-wrap white lacing. The proximal end of the Sound Chamber is conical. Finished 6/26/2018.

Translucent Purple. A v70 design rendered on 11/21/2017. Printed on 11/24/2017 on the FCMG Prusa i3Mk2 in 1.75 mm MakerBot Translucent Purple PLA. A five-wrap white lacing. Largely hand-sanded quite a while ago, but touched up on 6/26/2018.

Red PLA. A v72p design rendered on 4/17/2018. Printed in 3 separate prints 4/17–19/2018 on Clint's Pi3Mk3 in 1.75 mm Rigid.Ink Red PLA, 100µm layers, 100% infill @ 2400 mm/min. A five-wrap brown lacing. Finished on 6/30/2018.

CorkFill v74. A v74 flute rendered and printed in two prints on 5/8/2018. It was printed on Clint's Pi3Mk3 using a 0.60 mm E3D v6 nozzle in 1.75 mm ColorFabb CorkFill, ??µm layers, ??% infill @ ??2600 mm/min with a two-wrap white lacing. Finished 6/28/2018.

White nGen. A v76 flute rendered on 5/27/2018 and printed in a single print on 5/28/2018. It was printed on Clint's Pi3Mk3 in 1.75 mm ColorFabb clear (white-looking) nGen, 100 µm layers, 90% infill @ 2400 mm/min with a four-wrap brown lacing. Finished 6/30/2018.

Gold v76 / Black Lacing. A v76 design rendered on 5/31/2018 (`BodyProx` and `BodyDist`) and 6/3/2018 (the `Bird` component). Printed in 2 prints 6/6/2018 on Clint's Pi3Mk3 in 1.75 mm ColorFabb Champagne Gold nGen Lux, 100µm layers, 90% infill @ 2400 mm/min. Bird is fixed with a 100 cm long, five-wrap black lacing. Finished on 7/3/2018

Gold v78 / Brown Lacing. A v78 design. The `BodyProx` and `BodyDist` were rendered on 6/23/2018 and printed with brims on 6/24/2018 on Clint's Pi3Mk3 in 1.75 mm ColorFabb Champagne Gold nGen Lux, 100µm layers, 90% infill @ 2400 mm/min. The Bird component was rendered in three versions on 6/23/2018 and 6/25/2018 – a tied-on version, a version with peg holes, and a version with peg holes and wedges. They were printed in two separates prints on 6/23/2018 and 6/25/2018. Bird is fixed with a 101 cm long, five-wrap brown lacing. Shape of flue changed substantially in this version. See the ***SandF Dislocation Episode***, documented in the section below. Finished on 7/4/2018.

Realizations

Realizations from post-processing (sanding, assembling) 7 breath flutes:

- Bird Pegs do not work. They crack. Worse – they seem to invariably cause the base of the `Bird` to "stand away" from the Nest. Keep the Bird Pegs and Wedge `BirdStyle`, but make `BirdStyle=Tied` (the tied-on bird, with no peg holes) on `BirdStyle` the standard.
- The tap I bought from Amazon is pointed and cracks parts. However, I was able to easily grind it down on a grinding wheel.
- The Junction Peg Holes / Cylinders should be 1 thread – 1/32" – deeper. The Set Screws need to go in just a bit farther.
- Tuning variability from the body tube fully inserted to "as far out as I dare and slightly risky" is about 30 cents with a 3′ 4½″ (40½″, 103 cm) long body tube. Maybe lengthen the mortice to allow for more tuning??? Current Mortice length is 25 (including the foot flange), and it can probably go to 30.
- Do not force `BodyDist` into `BodyProx`! Use `SandS`. Use a metal file. Use `SandQ`. (Have not actually tried `SandP` yet). File the insides of the blades on `BodyDist`. File everywhere on the Junction Bevel of `BodyProx`. It should go in slightly snugly, but without very much pressure.
- The flange at the foot of the Mortice is wayyyy bigger than needed – and it wastes valuable distance stabilizing the body tube and lowering the amount of pitch change that can be accomplished by sliding out the headjoint from the body tube. The foot flange also reduces the print bed contact area, encouraging prints to become unstuck. Current foot flange length is 5 mm and can probably be 2.
- Could really use a sanding tool with the shape of the flue floor – a stick with the curvature of the floor and an edge that is aligned with the edge of the flue.

Photo Shoot

Here is a sampling of the versions and printed headjoints. The sequence proceeds from left to right in the back row, followed by the front row from left to right:

Here is the print of the finished and assembled v78 Headjoint with the tools used to finish the components:

And, for a laugh, here is a sampling of some of the failed prints over the last two years:

These photos were taken on the Canon in JPG format. Notice the red shift. Here is the setup for the photo shoot:

7/3/2018 Print of 98% SandQ and SandT in PLA

Print two sanding tools with smaller guide cylinders – needed for the last of the "Gang of Seven".

- Printed: July 3, 2018
- Source: `BFlute_078.scad`
- STL: `BFlute_078_SQ_CG_f125e980_20180702_1341.stl` (7.1 MB)
  `BFlute_078_ST_CG_f125e980_20180702_1341.stl` (11.4 MB)
- Factory: `BFlute_078_SQST_CG_f125e980_20180702_1341.factory`
- Profile: `Pi3Mk3_BFT_CG.fff`
- Based on: `Pi3Mk3_BFT_CG.fff`
- G-code: `BFlute_078_SQST_CG_f125e980_20180702_1341.gcode` (15.0 MB)
- Slicer: Simplify3D 4.0.1. Profile modifications: none
- Printer: Pi3Mk3/CG, 0.40mm brass E3D nozzle
- Bed Prep: Scrubbed with 91% IPA.
- Filament: Rigid.Ink Black PLA 1.75m
- VidSetup: (none)
- Video: (none)
- Predic build time: 3h 52m, Fil. length: 18.849 m, Plastic weight: 56.67g (0.12 lb), Cost 2.61
- Live Tuning: (none)
- Actual build time: 4h 48m
- Cum. print time: 19d 16h 33m = 472.5 hours
- Cum. filament: 555.74 m
- Printed part marked: *"SandT 98%" and "SandQ 98%"*

Results: Print worked great. They fit nicely in the seventh of the "Gang of Seven".

Lacing

This is a consolidation / updating of info on lacing.

There are currently two throat diameters: the older v76 size without the nest and the newer v78 design with the nest (slightly larger):

Four straight wraps with no twists, crossovers, or stretching of the leather:

- v76 no nest: 54.5 cm → 13.625 cm per wrap
- v78 with nest: 56.5 cm → 14.125 cm per wrap

A good tail length is about 15 cm (6″) and 5 wraps looks like a good amount, so total lacing length works out to:

- v76 no nest: 13.625 cm × 5 + 30 cm → 98.125 cm per wrap
- v78 with nest: 14.125 cm × 5 + 30 cm → 100.625 cm per wrap

This compares with earlier note on cutting lacing:

- On 7/2/2017: Lacing added: 30″ (76 cm) long medium-wide leather lacing of unknown origin. This provides a nice length for three wraps with two 6″ tails. [works out to 15.24 cm per wrap]
- On 11/25/20178: Added lacing cut from ArtMind Leather Lace Ivory spool: 37″ gives 6 total wraps plus two short tails after a simple overhand knot. Lacing requires about 5½″ (14.0 cm) per wrap.

… So the net result: count on about 14–15 cm per wrap plus 2 × how long you want the tails:

- For v78+ with 3 wraps and 6″ tails: 75 cm
- For v78+ with 4 wraps and 6″ tails: 89 cm
- For v78+ with 5 wraps and 6″ tails: 103 cm

Filament Filament Donation

On 7/5/2018, donated five spools of 2.85 mm filmament to the Westport Public Library:

Filament Moisture and Dehydration

To get a handle on filament moisture, I purchased various components:

Food dehydrator: Presto 06301 Dehydro Digital Electric Food Dehydrator + Presto 06306 Dehydro Electric Food Dehydrator Dehydrating Trays

Small hygrometers: EEEKit 5-pack Mini LCD Digital Electronic Temperature Humidity Meter Indoor Thermometer Hygrometer (Black)

Acu-Rite hygrometer: AcuRite 01080M Pro Accuracy Temperature & Humidity Monitor with Alarms

Dessicator: Eva-Dry E-333 Renewable Mini Dehumidifier

Vacuum Sealer: FoodSaver FM2000-FFP Vacuum Sealing System with Starter Bag/Roll Set, Black + Vertex Products 15" x 50' Vacuum Sealer Bag Roll - Commercial Grade 4 mil Heavy Duty - Extra Large 2" Wide Label Strip for Easy Writing

Filament holder / dry box: Polymaker PolyBox 3D Printer Filament Storage Box, Filament Holder, Spool Holder, Keeping Filaments Dry during the Printing

Airtight keepbox: Ziploc WeatherShield 44 Quart Storage Box, 4 Pack, Clear

Storage Bags: Plymor 13″ × 15″, 4 mil (Pack of 100) Heavy Duty Plastic Reclosable Zipper Bags. These bags actually measured variable from 3.0 – 4.0 mil using the micrometer to measure the outside rim of both the front and the back (actual measurements 6.0–8.0 mil for front and back combined). This is thicker than the ZipLoc freezer bags (2.7mil), ZipLoc storage bags (2.0mil) and generic resealable bags, which run around 1.5 mil. The re-sealable storage bags shipped with Rigid.Ink filament are 12½″ × 13½″ (12½″ × 12½″ usable after allowing 1″ for the zip closure), 1.5–2.0 mil (measured with micrometer).

How to use the Presto 06301: https://www.youtube.com/watch?v=-_8Lj_Z7VkY

Thomas Sanladerer , 5 ways to ruin your filament (and how to fix it)!
https://www.youtube.com/watch?v=WlmCc-vRNr0
3:35 – 4:40: keep below 50°C / 120°F material properties drastically change above this temp for a time – 1 – 2 hours?

https://blueprinted.com.au/blogs/wiki/106458374-how-to-preserve-and-restore-filament

> Common issue #1 Brittle Filament

A common misconception is that water causes filament to become brittle. The truth is filament including PLA is actually extruded into water to hydrate during the drying process. Without this important process filament wouldn't be flexible enough to spool.

Brittle filament is often caused by the plastic becoming dehydrated due to humidity in the air. Think of filament like dried spaghetti. When you put spaghetti into a boiling pot, it begins to re-hydrate which restores its flexibility (and its tastiness).

Another major culprit of filament become brittle is our favourite star! The sun. The reason? UV light degrades the molecule bonds which holds filament together.

In short. Humid weather and UV light are the main causes of brittle filament.

E-333 advised by support that it will not draw down humidity below about 30-40% relative humidity, but I have found this not to be true!

Small hygrometers appear to be accurate, but do not read below 10%.

One of the issues with the Vacuum Sealer is that it applies significant pressure to the spool. The FM2000 unit I am using allows you to halt the vacuum function at any point and begin sealing – a feature that would be important for vacuum sealing any delicate item such as a filament spool. The image at the right shows a partially used spool deformed by a full-power vacuum of the FM2000.

The SandF Dislocation Episode

While trying to sand the flue of the v78 nGen Lux headjoint on 7/3/2018 – the last of the "Gang of Seven", I found that the SandF tool diameter did not match (at all) the radius of the underside of the Bird component. I realized that the Differential Flue Bias development caused the entire flue shape to be flattened, making the pre-v78 SandF component useless.

It gets worse.

I started developing "Effective" radii for the Flue with the Differential Flue Bias, and echoing out the various radii in FlueCavity_PRF2 ():

- Initial flue radii:
  - FlueProxTRadius=17
  - FlueDistTRadius=18.2
  - FlueProxBRadius=11
  - FlueDistBRadius=17
- Effective flue radii after applying the Differential Flue Bias
  - EffectiveFlueProxTRadius=22.5
  - EffectiveFlueDistTRadius=23.7
  - EffectiveFlueProxBRadius=16.5
  - EffectiveFlueDistBRadius=22.5
- Relevant stations related to the flue:
  - EffectiveFlueProxStation=115
  - EffectiveFlueDistStation=59

So, it turns out that the top of the flue is not a cylinder, as previously assumed, but a truncated cone – a frustum – of radius 17.0 mm to 18.2 mm from stations 59 mm through 115 mm.

The SandF component had assumed it was a cylinder and has based its radius on Throat_ID (34 mm, radius 17 mm), modified by the XYExpand parameter and the presumed SandpaperThickness. The resulting radius for the SandF component with XYExpand=0 is 16.7 mm. So, SandF was using FlueProxTRadius as the basis for its curvature.

However, the top of the flue is not a cylinder, and could never have been properly sanded by a cylindrical SandF component. Furthermore, there is no truncated cone (frustum) that could properly sand the underside of the bird, since the Bird needs to be sanded longitudinally and there is only one point on a frustum that would match the underside of the bird.

It gets more worse.

Changing FlueProxTRadius from 17.0 to 18.2 actually works in the model (at least for a Large mouthpiece) – pushing the top end of the flue further into the nest area and moving the proximal floor of the flue up higher (more negative Z) and away from the lettering. However, the inflection point of the Bird changes, which alters the RenderBat_BirdComponentPolygonAngle (which should really be

called something like `BirdInflectionAngle`) setting from 59.9371° (v76 and before) and 61.8617° (v77) to 64.1934°. This would require newly printed `SandB`, `SandF`, `SandN` and who knows what other ramifications. Oyyy.

Proposal – major overhaul, undoubtedly with un-dreampt of ramifications – but …

- Eliminate the Bird Inflection point. Make the bottom rails of the Bird component flat – a la a Native American flute – by canting the entire flue up higher into the nest.
- Set `FlueProxTRadius` the same as `FlueProxBRadius` so that we `SandF` can use a simple cylinder.
- Reduce the Distal flue radius … move the whole thing in more towards the center
- Cant the face of the bird so that it prints vertically on the printer and can be printed without a brim without falling over.
- Can we make the nest shape independent of Mouthpiece size?
- Can we make the bird shape independent of Mouthpiece size?
- Can we make the `BodyDist` component shape independent of Nest Shape / Mouthpiece size?
- This eliminates the "action item" to set the Bird Inflection angle as a fixed value and calculate the bird-slicing polygon based on that item …

These changes are beyond the scope of what can be reasonably tackled in v78, or before the WFS convention. The plan is to hand-sand the one v78 `Bird`, complete the initial "Gang of Seven" headjoints, and pick this all up at a later date in the next major round of development …

Dishwasher Test of nGen

On 7/12/2018, I tested the `BodyProx` component from a failed print (v78, printed 6/24/2108) using nGen Lux in a full dishwasher cycle. The dishwasher is a MayTag QuietSeries 300, Model MDB7600AWS.

The dishwasher was set to "Heavy Wash" with the "Sanitize" option set.

Dishwasher Temperature

The Dishwasher entry on Wikipedia (https://en.wikipedia.org/wiki/Dishwasher, retrieved 7/13/2018) states:

> A dishwasher … cleans by spraying hot water, typically between 45 and 75 °C (110 and 170 °F) …
>
> Most consumer dishwashers use a 75 °C (167 °F) thermostat in the sanitizing process. During the final rinse cycle, the heating element and wash pump are turned on, and the cycle timer (electronic or electromechanical) is stopped until the thermostat is tripped. At this point, the cycle timer resumes and will generally trigger a drain cycle within a few timer increments.
>
> Most consumer dishwashers use 75 °C (167 °F) rather than 83 °C (181 °F) for reasons of burn risk, energy and water consumption, total cycle time, and possible damage to plastic items placed inside the dishwasher. With new advances in detergents, lower water temperatures (50–55 °C / 122–131 °F) are needed to prevent premature decay of the enzymes used to eat the grease and other build-ups on the dishes.

For commercial / industrial units:

> In addition to domestic units, industrial dishwashers are available for use in commercial establishments such as hotels and restaurants, where a large number of dishes must be cleaned. Washing is conducted with temperatures of 65–71 °C (149–160 °F) and sanitation is

> achieved by either the use of a booster heater that will provide an 82°C (180°F) "final rinse" temperature or through the use of a chemical sanitizer.
>
> …
>
> Unlike a residential dishwasher, a commercial dishwasher does not utilize a drying cycle (commercial drying is achieved by heated ware meeting open air once the wash/rinse/sanitation cycles have been completed) and thus are significantly faster than their residential counterparts. Washing is conducted with 65–71°C / 150–160°F temperatures and sanitation is achieved by either the use of a booster heater that will provide the machine 82°C / 180°F "final rinse" temperature or through the use of a chemical sanitizer. This distinction labels the machines as either "high-temp" or "low-temp".

However … this nGen test was done with an incoming water temperature below the recommended … see the next section:

Incoming Water Temperature

The temperature of the incoming water is 115.5°F (46.4°C) – the reading of a digital oven thermometer reading in a glass of hot water in the sink next to the dishwasher (the prescribed method of testing incoming water temperature from the MayTag manual for the dishwasher). The *Dishwasher Use & Care Guide* for the Model MDB7600AWS dishwasher states (page 6):

> For optimal cleaning and drying results, hot water is necessary. The incoming water temperature should be 120°F (49°C) to properly activate the detergent and melt greasy food soils. To check the incoming water temperature, turn on the hot water faucet nearest the dishwasher and let it run into a glass in the sink. Place a candy thermometer in the glass and check the temperature once it has stopped rising.

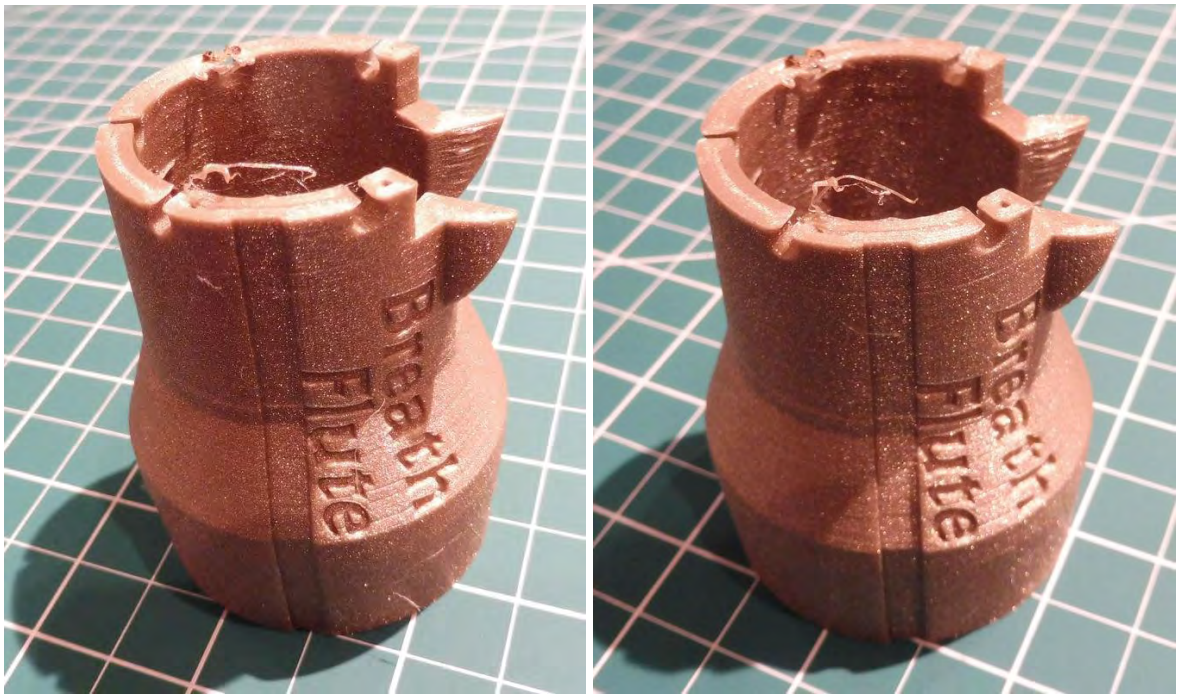
Notes from the GE Appliances web site (http://products.geappliances.com/appliance/gea-support-search-content?contentId=18924):

> Dishwasher Correct Water Temperature
>
> Water entering the dishwasher must be at least 120 degrees Fahrenheit and not more than 150 degrees Fahrenheit for the best cleaning and to prevent damage to the dishes.
>
> You can check your water temperature with a candy or meat thermometer: Turn on the faucet nearest the dishwasher, place the thermometer in a glass and let the water run into the glass until the temperature stops rising (one minute or more).
>
> If the water is not hot enough, the water heater may need to be adjusted. It is always a good idea to let the water run in the sink until it gets hot before starting the dishwasher. This makes sure the dishwasher is starting out with the hot water it needs for good wash and dry performance.

Results

The dishwasher cycle appears to have had no effect on the print. Even the thin, loose strands of filament at the top of the print that were left over when the print failed seem to have not been affected.

Here are before and after images:

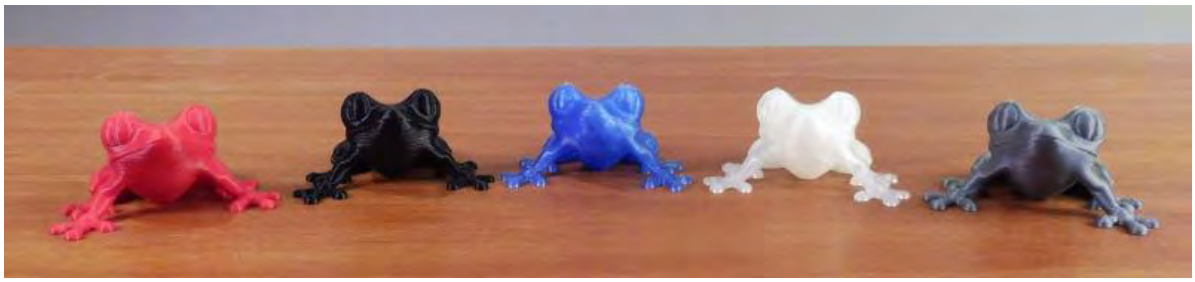


Frogs

Printed an array of frogs from the 150 µm version of the pre-loaded G-code file on the Prusa SD card. Note that the attributes of the print are designed for PLA (210°C / 60°C) and all are printed in the center of the build plate.


Frogs from these materials, in the order they were printed (all 1.75 mm):

- 2 Rigid.Ink Red PLA (a long time ago)
- 7 Rigid.Ink Black PLA (up through 7/12/2014)
- 5 Rigid.Ink Translucent Blue PLA (7/13/2018)
- 4 Rigid.Ink Natural Clear PLA (7/13/2018)
- 4 Prusa Silver PLA (7/14/2018)




One Black and one Translucent Blue given to Ken & Olga 7/12/2018.

WFS Convention Presentation

On 8/2/2018, we did a one-hour presentation at the World Flute Society Convention (WFS2018) titled "Creative Music Facilitation Techniques". Did about 6 minutes of it on the Breath Flute. Went over well!

Breath Flute #79 – First Public Release

This version was used to create in initial public ("shakedown") release. This coincided with the development of www.BreathFlute.com during August 7–10, 2018 (although an earlier "placeholder" version of the site had been up since 2016).

Breath Flute #80 – Improvements Beginning 7/5/2018

This version was initiated to on 7/5/2018 as the basis for substantial design changes proposed in several sections above: the ***Realizations*** section of ***Post-Processing of the first 7 Viable Headjoints***, the ***SandF Dislocation Episode***, and unresolved issues from version 78. However, while these issues were logged and collected starting on 7/5/2018, no actual work was done on these issues until late August 2018.

> **Note:** this list does ***not*** include items from the ***Long Standing Issues*** roster above.

- Identify the parameters and options in the code that are viable vs. defunct. Maybe several choices:
  - viable (can be turned on an off and will work),
  - documentation (not operational, but preserved to identify certain places in the code),
  - preservation (not operational, but retained to preserve existing code that might be useful in the future),
  - nascent (added as an option, but never really implement)

  … and add documentation about this in the Developer's Guide. ***TBD***
- Undertake destructive testing on the useless sandinging tools that were printed – where do they fail? ***TBD***
- There is an issue with printing on the Foot component: the lettering is angled down at about 9.4° (actually half that … reporting had a bug) from vertical (the reported "Shell angle" for MorticeB now echoed on the output of some components). This angled-down printing will invariably cause some free-standing "islands" of "printing in space" – completely unsupported. What if we used the Flare parameter?? ***TBD***
- Bird Pegs do not work. They crack. Worse – they seem to invariably cause the base of the `Bird` to "stand away" from the Nest. Keep the Bird Pegs and Wedge `BirdStyle`, but make `BirdStyle=Tied` (the tied-on bird, with no peg holes) on `BirdStyle` the standard. ***TBD***
- The tap I bought from Amazon is pointed and cracks parts. However, I was able to easily grind it down on a grinding wheel. ***TBD***
- The Junction Peg Holes / Cylinders should be 1 thread – 1/32″ – deeper. The Set Screws need to go in just a bit farther. ***TBD***
- Tuning variability from the body tube fully inserted to "as far out as I dare and slightly risky" is about 30 cents with a 3′ 4½″ (40½″, 103 cm) long body tube. Maybe lengthen the mortice to allow for more tuning??? Current Mortice length is 25 (including the foot flange), and it can probably go to 30. ***TBD***

- Do not force `BodyDist` into `BodyProx`! Use `SandS`. Use a metal file. Use `SandQ`. (Have not actually tried `SandP` yet). File the insides of the blades on `BodyDist`. File everywhere on the Junction Bevel of `BodyProx`. It should go in slightly snugly, but without very much pressure. *TBD*
- The flange at the foot of the Mortice is wayyyy bigger than needed – and it wastes valuable distance stabilizing the body tube and lowering the amount of pitch change that can be accomplished by sliding out the headjoint from the body tube. The foot flange also reduces the print bed contact area, encouraging prints to become unstuck. Current foot flange length is 5 mm and can probably be 2. *TBD*
- Could really use a sanding tool with the shape of the flue floor – a stick with the curvature of the floor and an edge that is aligned with the edge of the flue. *TBD*
- The changes to flatten the flue in order to keep the entire flue floor below the nest rails have caused the `SandF` component to the wrong shape. This work involves the "Differential Flue Radius", implemented on 6/8–12/2018. The change is significant and noticable … new calcs will be needed for `SandF`! *TBD – this turned into a major hairy hairball … see "The SandF Dislocation Episode" documented above.*
  - Eliminate the Bird Inflection point. Make the bottom rails of the Bird component flat – a la a Native American flute – by canting the entire flue up higher into the nest. *TBD*
  - Set `FlueProxTRadius` the same as `FlueProxBRadius` so that we `SandF` can use a simple cylinder. *TBD*
  - Reduce the Distal flue radius … move the whole thing in more towards the center *TBD*
  - Cant the face of the bird so that it prints vertically on the printer and can be printed without a brim without falling over. *TBD*
  - Can we make the nest shape independent of Mouthpiece size? *TBD*
  - Can we make the bird shape independent of Mouthpiece size? *TBD*
  - Can we make the `BodyDist` component shape independent of Nest Shape / Mouthpiece size? *TBD*
  - This elimiates the "action item" to set the Bird Inflection angle as a fixed value and calculate the bird-slicing polygon based on that item … *TBD*
- Implement a new option for the `SandS` and `SandY` sanding dowels – `n0` and `n1` for "Notch" … `n0` eliminates the notch for the vice grip to make it easier to use as a hand tool. *TBD*
- Establish a new "class" of options – "minor" options that work just like the existing MBIZE "major" options, except they do not get a letter in the "`MBIZE`" title or the check-matrix in the Developer's Guide, because they only apply to a very few components. *TBD*
- Consider the possibility of using Velocity Painting / Tattoo techniques to apply a pattern to the surface of the print. See https://www.youtube.com/watch?v=HdKaKKeyz7g. *TBC*

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