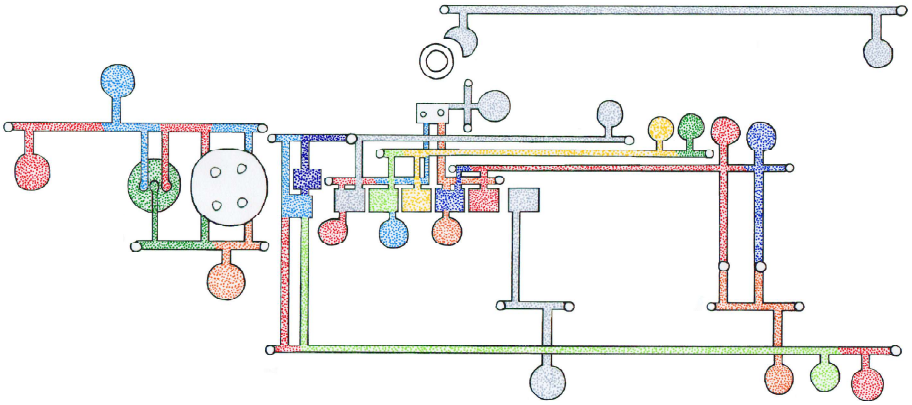

A schematic diagram of the one-handed clarinet by Sophie Hyman

THE ONE-HANDED CLARINET

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Barrel made from nylon, and two barrels made from wood fill by Sharon Jones.

CONTENTS

Exploring Different Processes

Different components of the one-handed clarinet have been 3D printed, using three different processes, FDM, SLS and SLA.

Having started to print components, we have found that the bore is accurate enough to not require machining, which has been a big breakthrough for the team. The bore sizes have been within the tolerable limits for traditional clarinet making. Furthermore, we can easily change the bore size to compensate for differences once components have been printed.

All three materials are lighter than the original wooden one-handed clarinet. This is ideal for young learners, as well as adult clarinettists with the use of just one hand to take the weight of the instrument, with assistance from a sling. Alongside a lighter weight, we need to ensure that the chosen material maintains good tonal qualities.

The density of the models printed varies widely:

- African Blackwood Top Joint - 141gm
- FDM Top Joint - 48gm
- SLS Top Joint - 102gm
- SLA Top Joint - 119gm

The density of the SLS and SLA models are similar, and we found that they produced a similar tone.

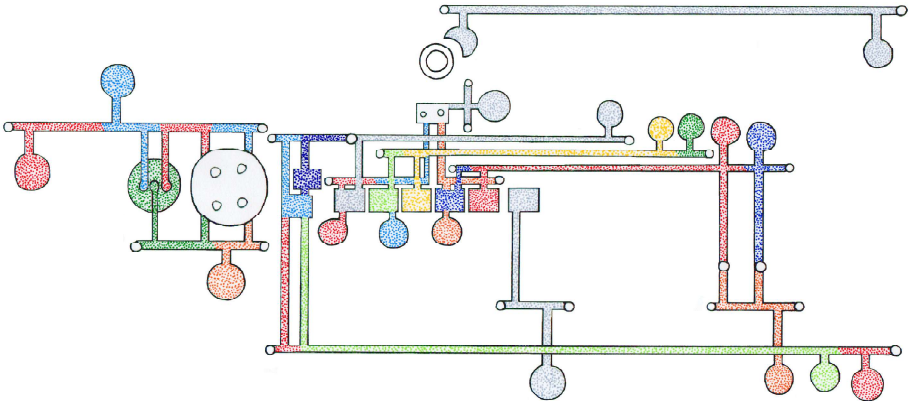
FDM

Sharon Jones printed components using the Fused Deposition Modeling printing process.

These models have proven that our concept works. Although the material itself machines very well, we don't believe that it is usable for this project, due to issues with porosity.

However, Sharon has started to explore using PLA as a binder with sawdust embedded, which may solve the issues of porosity and machine-ability.

FDM printed clarinet joint by Sharon Jones.



A schematic diagram of the one-handed clarinet by Sophie Hyman

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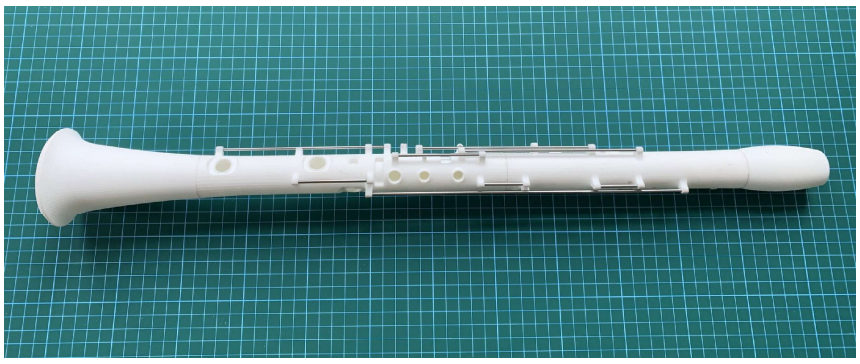
SLS

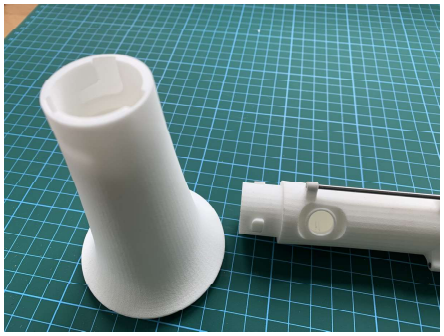
Freddy Holdsworth, from Arts University Bournemouth, printed components using the Selective Laser Sintering process.

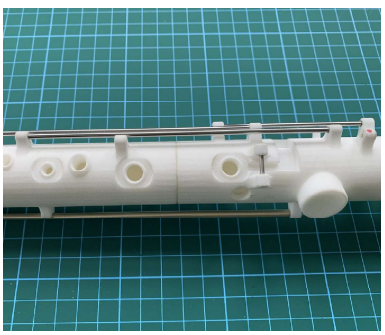
This model has good acoustic potential, but components printed in this way can be brittle. The finish isn't smooth, which isn't necessarily a problem. Although the tone holes need a smooth surface to seat pads properly, this can be overcome relatively easily.

This model can take a thread, and Peter has started mounting rods onto it, and drilling smaller holes for springs in a traditional instrument makers way. The longevity of this is not yet known but can be overcome by attaching springs to keywork instead.

SLS printed components can fluctuate at different temperatures, so consideration about how this model may react to being stored in a car on a warm day need to be taken into account.







SLS printed components by Freddy Holdsworth, with pillars mounted by Peter Worrell.

SLA

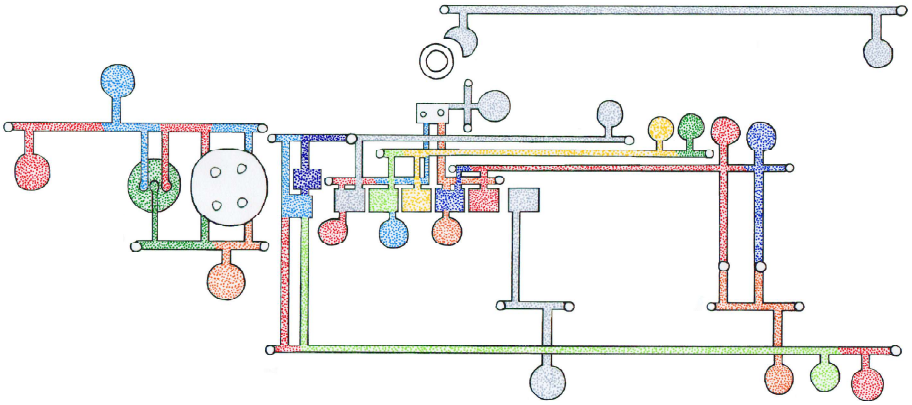
Dr Rachel Saunders, Senior Experimental Officer and Honorary Lecturer at The University of Manchester, has printed components using the Stereolithography process.

This clear model is excellent for helping us better understand the holes into the body of the clarinet, where we can clearly see the tapered draft and radius.

Screws and springs work well with this model, and no thread locking compound is necessary. It also hasn't been necessary to apply a smooth surface to tone holes for pad seating. The resin used is stiffer and less viscoelastic than the other two models. However, this process is the most expensive of the three tried, and setting up a new vat of material is costly.

SLA resin may discolour and go yellow overtime as it reacts with UV. This could be minimised or prevented by using a spray coat of clear varnish. There are 12 different SLA resins available, and custom formulations are available.

When investigating the acoustic aspects of the 3 types of printing, we found that SLA seems to offer the best examples closest to what we are trying to achieve.



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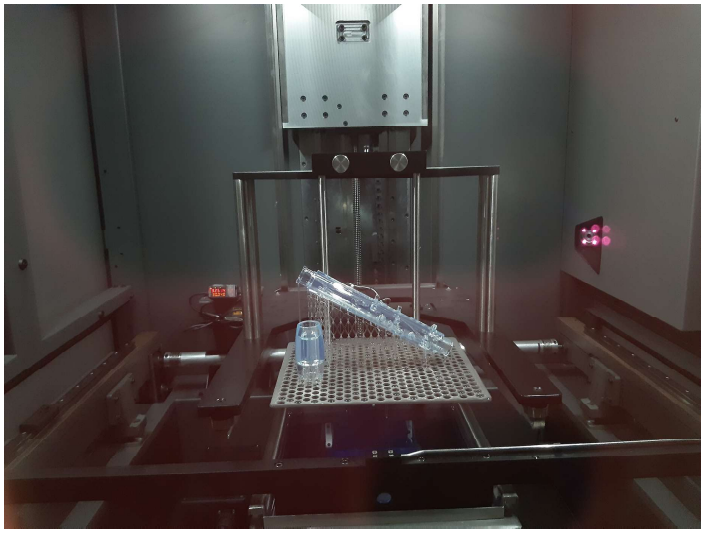


SLA printed components by Rachel, using the NEO800 from RPs support and Somos Watershed resin.

Looking forward, more prints are going to be necessary to understand the dimensional stability of these materials. We are now looking to print a full body, bell and barrel in SLA. We are also going to calculate the costs of printing the one-handed clarinet using this process. Although this is the most expensive of the three options explored, SLA is available to the DIY market, so we are hopeful that costs will come down over time.

Peter will be working with Michael Sanders to redesign certain aspects of the body. This new design will enable a simpler construction of keys (see p. 4).

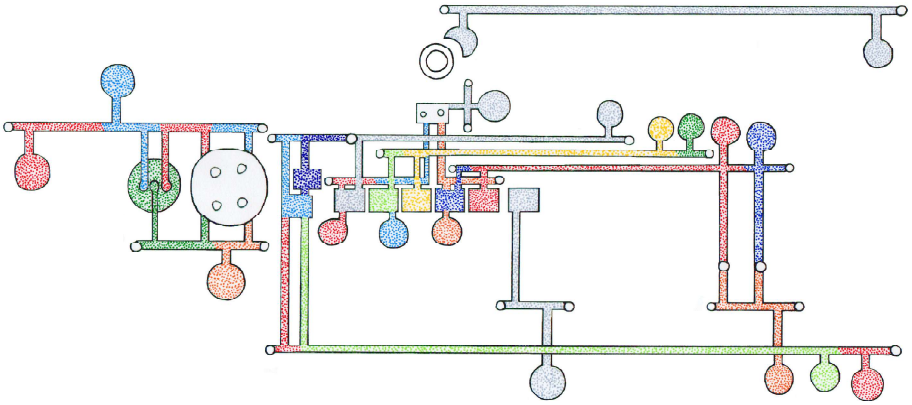
Inspiration from Industry

Peter Worrell had a chance to meet with Morrie Backun of Backun Musical Services over Zoom to discuss the advances of 3D printing in woodwind manufacture. They talked about the following different types of printing and the relative merits of each process:

- FDM
- SLS
- SLA

The team would like to thank Morrie for his time and thoughts about how the project can move forward.

BACKUN MUSICAL services



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Examples of bridge keys on the one-handed recorder by Peter Worrell.

An example of traditional clarinet pads.

Re-designing Keywork

We have been exploring different methods of key making for instruments in general. Currently on the original model there are 3 bridge keys and 1 pinned key. These are 2 keys that operate between a single set of pillars. The traditional method of making these keys requires more components and is tricky to assemble on the basis of a custom instrument. Jigs and fixtures would help in the traditional method but these are time consuming and costly, therefore hand made at the moment. Simplifying the mechanism makes the manufacture of these pieces less time consuming but requires a double pillar set up. As the 3D drawings can be modified to accommodate this, it seems now is the right time to change this process.

Producing keywork is the most time-consuming part of the current one-handed clarinet manufacturing process. Materials such as carbon fibre, ABS, PLA and FDM are being considered, as well as alternative methods of gluing components together, such as using 2 Pack Epoxy resins. The final product need to be smooth, comfortable to handle, and glue to other components successfully.

Re-thinking Pads

Traditional pads vary considerably in composition, so we have decided to not go down this route. We believe we have found a solution in neoprene. Peter Worrell has used this material on keyed recorders and simple system flutes. The material is airtight and has a medium soft density. As most of the instrument keys are in the closed position the seal gets deeper in time and keeps the instrument air tight. The toneholes on the instrument are raised by 0.8mm and have a flat section onto the body. As the the indent gets deeper the pad will eventually come to rest on the flat section creating a double seal. We are confident that this design will keep the instrument airtight and less maintenance will be required.

Using this solution means that no pad seating is required, making setting up the new one-handed clarinet far quicker and easier than the current instrument. We are planning on exploring different adhesives to glue these new pads into the pad cups.

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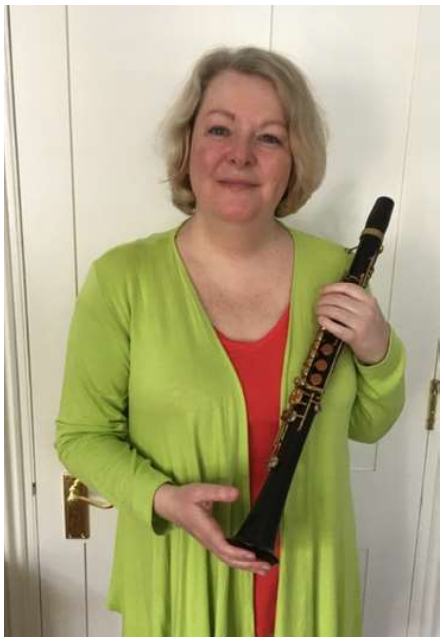


Clare with a one-handed clarinet.

The One-Handed Clarinet in Context

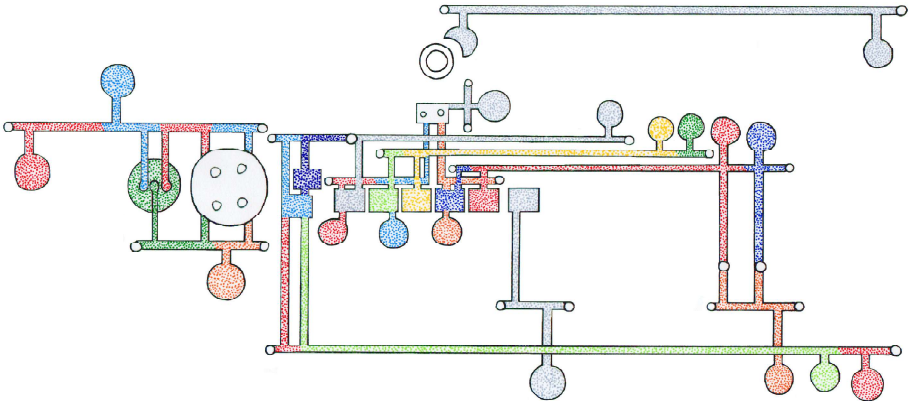
In our updates, we like to highlight the difference that one of these instruments can make to someone's life. This month we asked Clare, the clarinet teacher of Maria who was featured in our April update...

"The wonderful thing about music is that it brings people together and provides a source of joy. Being able to ensure that it can do this for everyone, and not just those with two fully-functioning hands or arms, is therefore really important to me. As a woodwind teacher, I want my lessons - one-to-ones and whole class groups - to be genuinely inclusive. And as chair of a charity that supports children with upper limb differences (www.reach.org.uk), finding a way to avoid artificial limits being placed on children's progression is very important to me.

"I have heard too many stories of children with disabilities being marginalised when it comes to their class learning an instrument, because no suitable instrument is available to enable them to participate properly and in a way that would allow them to progress beyond the first three notes. How can we possibly be happy with a system that closes off this source of joy to students simply because of their disability?"

"The one-handed clarinet changes all that. It has been wonderful to see the progress that Maria has made with her playing now that she has an instrument that is adapted to suit her. If these instruments were more readily available, it would be possible for other children to benefit too. And there are obvious benefits too for players who become disabled later in life, whether by a stroke or accident or whatever. Peter's professional clarinet is an absolute miracle of design and superlative craftsmanship, but having cheaper and lighter versions available for beginners or those who are forced to switch to a one-handed instrument later in life would be a godsend for inclusive music making."

When it became clear that there was no available one-handed instrument for Maria to hire, we started fundraising to cover the cost of buying one for OHMI that Maria could hire. We did a range of things, from busking at local stations, writing to potential benefactors for grants and touting our VirginMoneyGiving page around friends, family and colleagues. Thanks to a particularly generous donation from Euroclear, we were able to raise just under £16,000, almost enough for three one-handed clarinets. And we were really pleased with that achievement - and yet also very conscious that this is a drop in the ocean compared with the number of students who could potentially benefit from these wonderful instruments."



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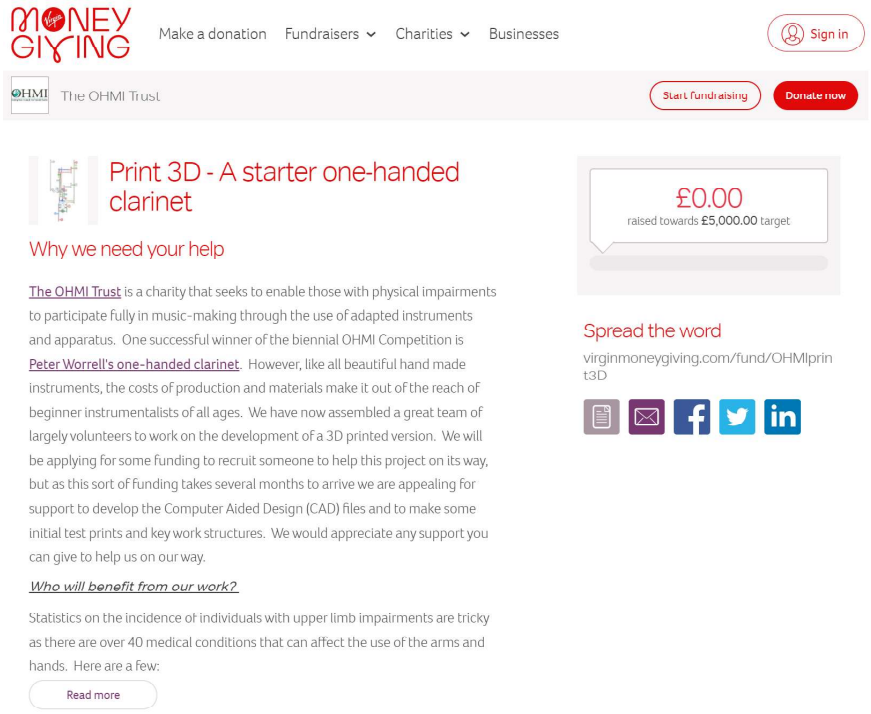
Funding Applications and Fundraising

Professor Brian Derby (Professor of Material Science) and Dr Rachel Saunders met with Dr Jacob Harrison (Director of the OHMI Research Partnership) and Rachel Wolffsohn (OHMI General Manager) last month to discuss different funding possibilities. We plan on applying for funding to support some further research, which Jacob is going to prepare applications for. The turnaround for a response for this type of funding is at least 6 months, so we have also set up a Virgin Money Giving page which can be accessed here.

We plan on using donations from this to fund initial print runs so that Peter can work on a possible key work structure and revised CAD files for this.



NEXT MEETING:

Date and Time TBC
Access: Please email rachel@ohmi.org.uk
to request a link to the meeting