

In the case studies I have interviewed three people, from diverse crafts backgrounds, who have dealt with the problems of limited materials. Each has a very different and particular approach to using 3D printing: Jonathan Keep and Michael Eden both share a background as practising potters. Marianne Forrest is primarily a clock and watchmaker. I also wanted to interview people who used the technology in very different ways. Jonathan has an extremely hands-on, do-it-yourself approach that starts with him building his own machine and, in essence, writing his own software, in order to build pots that relate to his practice as a thrower. Michael Eden's main aim, in his own words is:

*to communicate an idea or tell a story in the form of a three-dimensional object and in order to do that in a lyrical way I choose the appropriate tools. It does not matter to me whether they are a computer, the potter's wheel, the 3D printing machine or the kiln; they are all tools and require a degree of craft skill to do the job well.*

Marianne Forrest uses the technology as much as a designer than as a craftsperson, in the sense that it is a tool to enable her to achieve a desired result and it was not until she could print in metal that she began to use the technology.

## CASE STUDY

# JONATHAN KEEP

Jonathan Keep was born in Johannesburg, South Africa and educated at Natal University and the Royal College of Art. He is a well-known ceramic artist, he has shown internationally, been featured in the influential book on contemporary ceramics *Breaking the Mould* and has regularly shown at the prestigious Crafts Council 'Collect Fair'.

Jonathan describes his practice as an 'artist-craftsperson', although he has a background in fine art, Jonathan explains that: "In South Africa in the 1970s European cultural notions of fine art were being pulled apart". So he is happy to call himself a potter, "in a European context that puts you in the crafts but in a Southern African context being a potter was a mainstream artistic activity".

Jonathan's practice includes sculptural works and some functional thrown ware as well as 3D printing. In relation to 3D printing Jonathan's view is that "As far as I am concerned 3D is just another tool that enables your work with clay, sometimes I am throwing forms and cutting them up, other times I'm using coil building, other times I'm using 3D printing".



Jonathan Keep, 'Iceberg', 2012. © Jonathan Keep.

He first started to use 3D printing in 2011 as a result of seeing the work of the Dutch Design Company Unfold, who added a pressure-driven syringe to a Bits from Bytes RapMan printer in order to print clay. However, he first started using Computer Aided Design programming in 2002 after a residency in Denmark, where he then returned in 2003 for a workshop around digital work and ceramics. In 2007 he became interested in the sort of forms could be created through 3D software so went to another symposium around ceramics and digital form and it was there that he learned about using the Z Corp printers to print clay. However, Z Corp machines were expensive and he also learnt that more DIY-style home printing kits were available for less than £1000. Jonathan therefore purchased a Bits from Bytes RapMan self-build machine, with a converted print head to take a pressurised syringe, which is used to extrude ceramic slip casting clay through a nozzle.

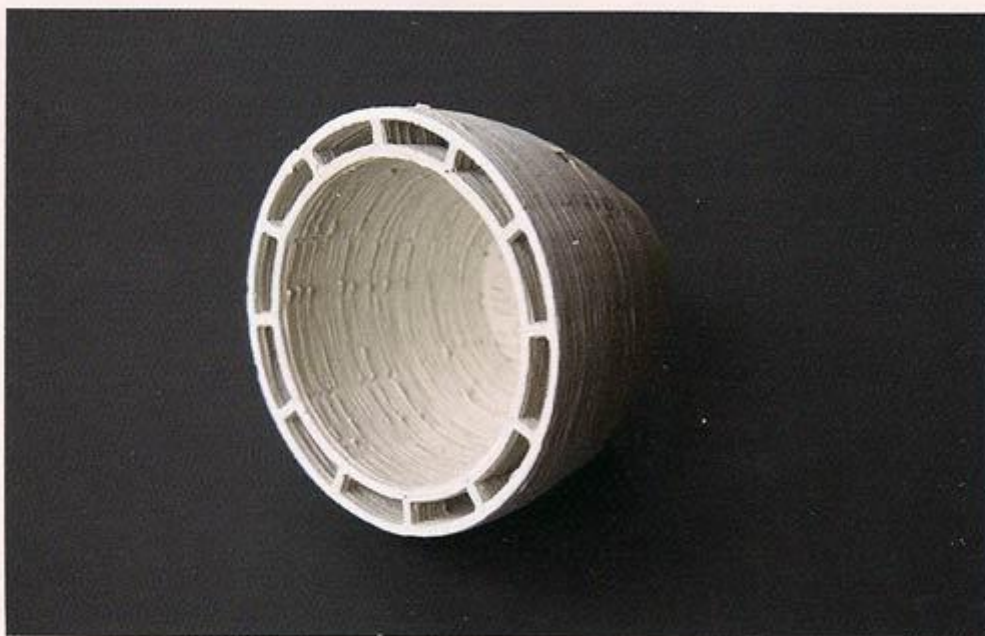
Currently, around a third of Jonathan's work involves 3D printing, mainly for his more sculptural pieces, but he still uses throwing for making his range of domestic ware. Jonathan explained that he uses 3D printing as a way to realise forms that have been computer generated:

*I am particularly interested in form and the natural evolution of three-dimensional shapes and how humans respond to form. The patterns and systems that go into making natural forms can be explored in computer code, and it is to realise*

*this code as physical objects that I am using 3D printing. This is just not possible with traditional processes. However the printing technique I use is very close to the technique of traditional coil build pottery - it could almost be seen as mechanical coiling process. What printing offers is a new way of working that includes the computer as a tool that for me becomes much more integral to the way of creating forms.*

During my interview with Jonathan we discussed the lead-up to the actual process of printing. Jonathan made a comment that belied the notions of material qualities usually so important to a craftsperson:

*The way of working is often more important to me and less so the qualities. Because I am interested in the mechanics of form, computer coding can start to give you an insight into that. I have taught myself basic Java coding so the actual forms aren't like the usual ones you would get in Rhino, but I am using code libraries for a cylinder for example then I can start distorting that cylinder through random mathematics etc. So I then get a mesh that I can capture on computer, then output to a printer and create a physical form, and there is no other way I could do that (by hand) or to do it another way would be pointless.*



Unfold, 'Potje', 2009.  
The first vessel Unfold printed on their ceramic printer in 2009. © Unfold.



Jonathan Keep, 'Random Growth', 2012. Line of 3D-printed ceramic pots. © Jonathan Keep.

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The computer code is written using 'Processing' – an open source programming language based on JavaScript. 3D files are captured or exported from these sketches and cleaned up in the open source 3D software 'Blender'.<sup>7</sup> In the Blender program Jonathan may adapt and recreate the initial mesh quite considerably. The 3D file is then further processed through the printer software, (Bits from Bytes, BfB Axon) to produce 'G-code'. G-Code is a programming language developed for CNC milling that is read by the Bits from Bytes 3D printer. Axon is a user-friendly version of Skienforge,<sup>8</sup> the standard freeware software for low-cost 3D printers.

It may be helpful to provide a little clarification here. The Axon software slices the 3D model and generates a series of linear tool paths, which are sent to the 3D printer to control the movement of the print head. Jonathan configures the software so that it only builds the external surfaces. The infill information the software generates is excluded from the build. This means the object will be built with a wall thickness that is determined by the width of the syringe nozzle he is printing with, and cannot be varied. This is different to the normal process for a 3D printer, which is to create a virtual solid object in 3D software, with the option of a specified wall thickness.

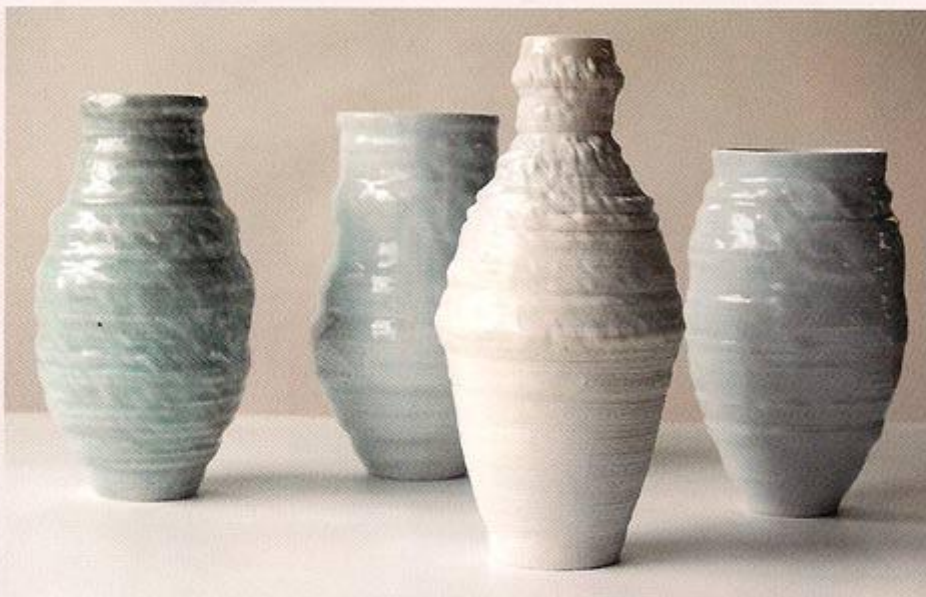
In terms of physical hardware Jonathan has a Bits from Bytes RapMan with a converted head to take a syringe. He explains that he comes from a Meccano sets background, giving him the knowledge to undertake the fairly complex process of constructing a self-build 3D printer. Jonathan states that the physically printed ceramic forms are solely created with 3D printing, but thereafter only traditional technologies are used to fire and glaze the objects. However, during the build process he intervenes either with his hands – to keep a section supported whilst printing – or with a hairdryer, to quickly dry a section so that it will not collapse during the build process. In essence, Jonathan has a very interactive build process, synonymous with being a hands-on traditional thrower: “I don’t go beyond 45 degrees but even then it bulges and I’m in there with a hairdryer drying it as quickly as I can, but I’ve given up – bowls just don’t work”.

Jonathan’s 3D printer has been converted from a fused deposition modelling (FDM) printer (that uses liquid plastic) by the removal of the FDM print head and replacing it with a pressure system that drives clay through the nozzle of a syringe. He uses a syringe that deposits approximately 1 mm of clay width in the horizontal axis, with 2 mm in the vertical axis and runs the syringe at a pressure of 3bar. This means that Jonathan has to clean up the print as it finishes because you cannot just turn off the pressure. At the CFPR we print clay with a much finer auger system (a type of screw thread between the syringe and the deposition head) to create a more even flow and combat some of the start and stop problems. However, Jonathan has an interesting view on these issues:

— My attitude to the barriers of 3D printing is very pragmatic – I don’t see them as barriers. I work within the limitations of what I’ve got. People [say] to me – aren’t there other ways you can feed in clay to extend your syringes? and so forth (to make a bigger pot). What I do is I cut up the mesh in Blender and will do two or three prints to get more scale, then assemble them and because they fit perfectly you just put them with the other half. I’m more concerned with the process than trying to re-engineer the machine every time. It’s what you do with it that’s the most important aspect, so once I saw the Bits from Bytes Rapman had a syringe on it I thought that’s the one for me.



Jonathan Keep, 'Salt Pots', 2012. © Jonathan Keep.



Jonathan Keep, 'Britten', 2012. © Jonathan Keep.



Jonathan Keep, 'Drop', 2012. © Jonathan Keep.

Jonathan can build two halves of an object, and using slip he can stick them together as greenware, quite easily, using a traditional craft practice. I would argue this is a really interesting solution using tacit knowledge of materials to solve a problem, by making the most of the inherent properties of clay. He elaborates on his process: "printing is a very small part – a bit like throwing – of the process. To get to the finished article there are all sorts of other traditional ceramic processes that take place first. You know, the glazing and the firing etc."

This is particularly true of ceramics and perhaps less so with some of the other processes and disciplines, but it

is clear that all of the craftspeople I talked to have some form of intervention in the process of making. These aspects of Jonathan's practice seem to be at odds with his comments regarding progress on material qualities. For an established craft practitioner, known for his craft skills and obvious tacit understanding of materials, when it came to 3D printing I found it quite hard to work out where Jonathan's aesthetic sensibilities lay.

This may be because the process is still relatively new to Jonathan as well as to the discipline and he is still formulating his practice.