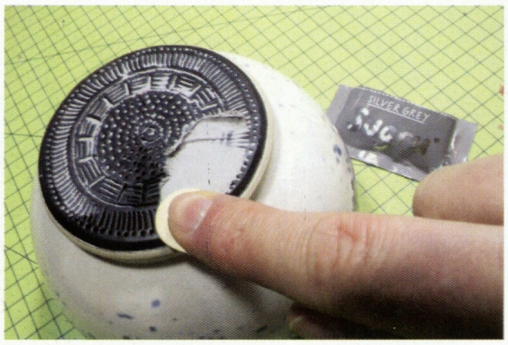
Ceramics
Technical

Inside



Cover image:
Stacked soda fired espresso cups.
Lisa Hammond's Maze Hill Pottery, London. Image credit: Florian Gadsby.

New technologies for the ceramics studio

Written by **Anna Calluori Holcombe** and **Thomas Storey**

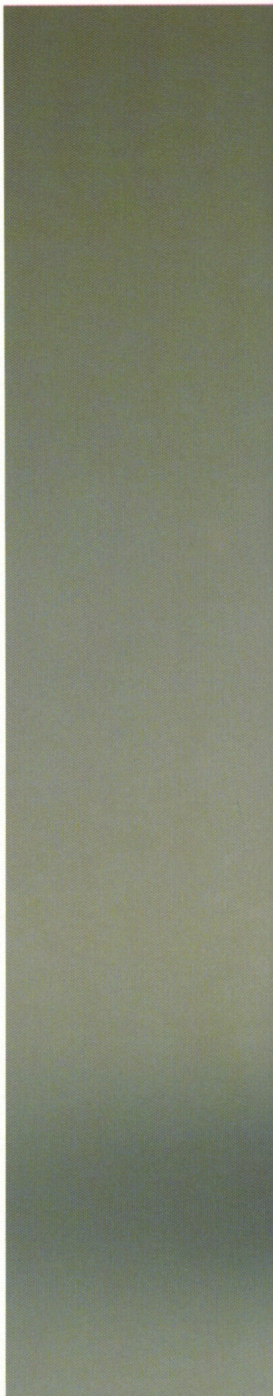
Typical reactions to the use of 3D technologies in the making of ceramic work range from fanatical interest to fear of the unknown. This article will focus on how scanning, printing and modeling technologies can be used to design, model, prototype and even create ceramic objects. Contemporary ceramic artists and designers are using these technologies to create their work. The case will be made that this new and accessible technology is "just another tool in the tool box."

Criticisms of 3D fabrication in craft related discourse largely center on a loss of materiality, how the human touch is replaced by the inhuman algorithm. These indictments are rooted in often-narrow views of the actual operation of this technology. 3D printing can be considered an abstraction of production. Form and material is manipulated independently. If the process of craft can be seen as a relationship between the maker and the object, then digital fabrication is an expressive, precise and poetic language with which maker and object can speak to each other.

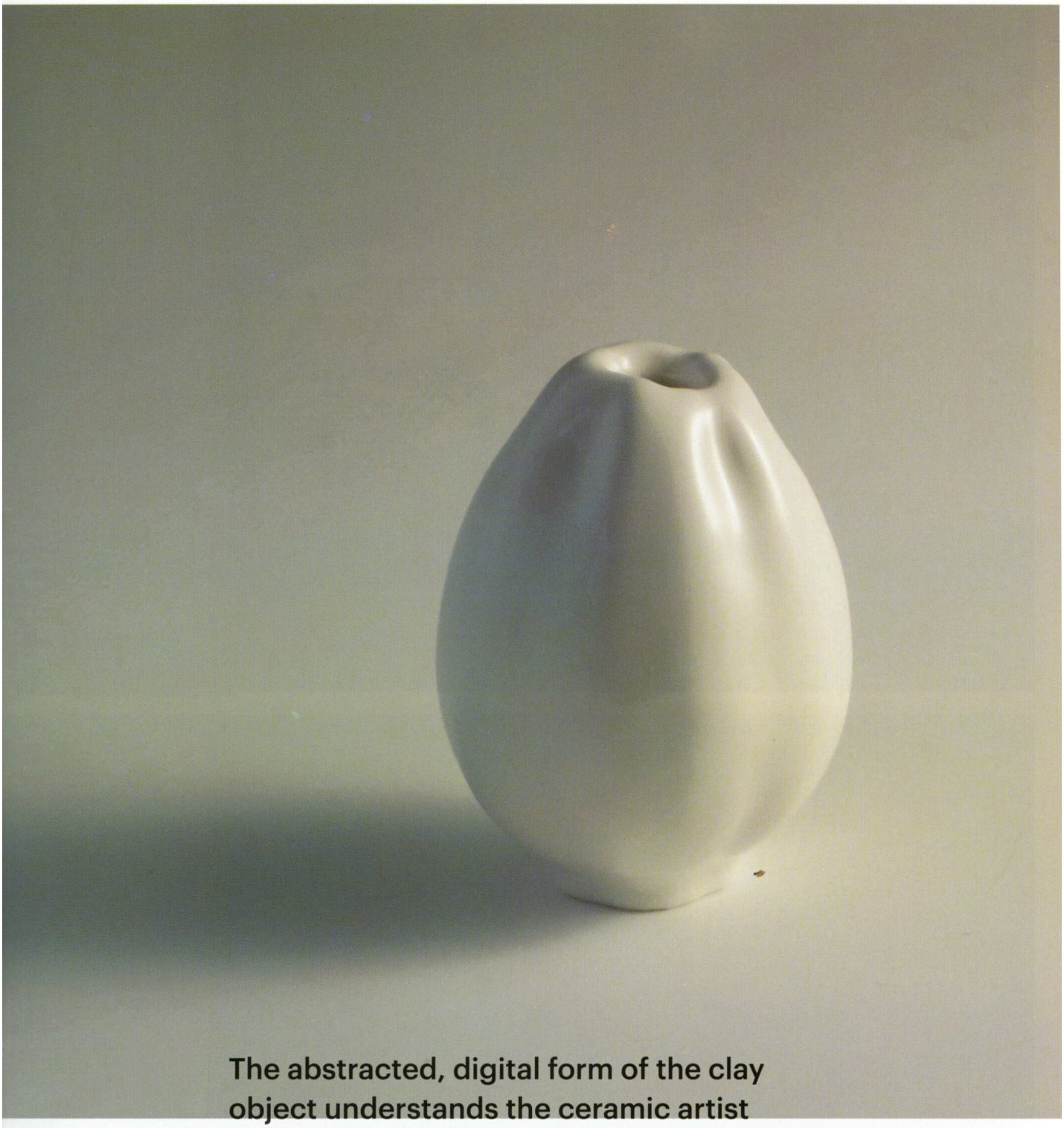
Calluori Holcombe is often asked, "Why use digital 3D technology for ceramics?" The answer is multifaceted. The files are easily reproduced, altered, and resized. They can be transported via email or flash drive. There is a degree of speed and flexibility not found in hand modeling and ability to model in a way not possible by hand. The virtual models can be viewed easily from any angle, and multiple perspectives can be shown on-screen simultaneously. And lastly, 3D scanning and printing processes can produce durable models in a relatively short amount of time.

Clay responds to the maker through the manipulation of the hand. Force, friction and feeling are the interface between maker and object. The abstracted, digital form of the clay object understands the ceramic artist through parameterization, becoming not just a form, but also a potential for a multitude of forms, and a multitude of materials. The vessel can be stretched, morphed, scaled, chopped, sliced, multiplied, fractured, inverted, dented and crushed. Digital fabrication does not lack materiality; in fact it affords multi-materiality. The 3D model of a vessel is not itself a vessel, but a set of potentials.

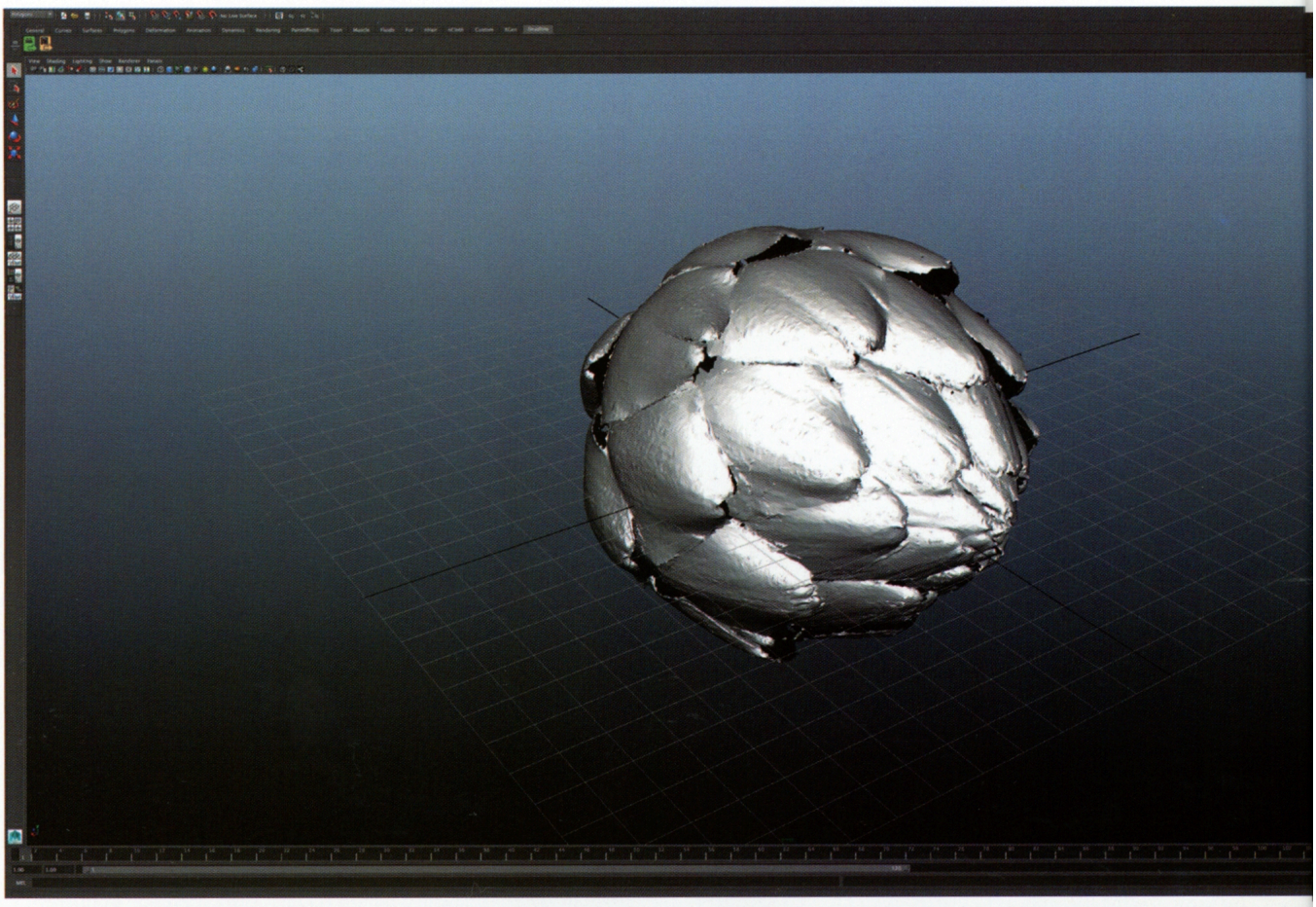
Power Of Making, The Importance Of Being Skilled is a book sponsored by collaboration between the Victoria & Albert Museum and the Crafts Council, England. One chapter by Ele Carpenter addresses the issue of de-skilling through the current proliferation of the DIY movement. She finds this movement uses both old and new technologies and any tools or materials needed to make. She states, "This approach acknowledges digital making as craft, as discussed by Richard Sennett in The Craftsman. Sennett argues that the open-source operating system Linux, for example, is a public craft because it is a tool that actively shapes the world around us through collective making." She goes on to say, "Embracing digital making as a craft enables space for experimentation and collaborative production as well as an in-depth understanding of how things work and how to build and repair them.[1]"

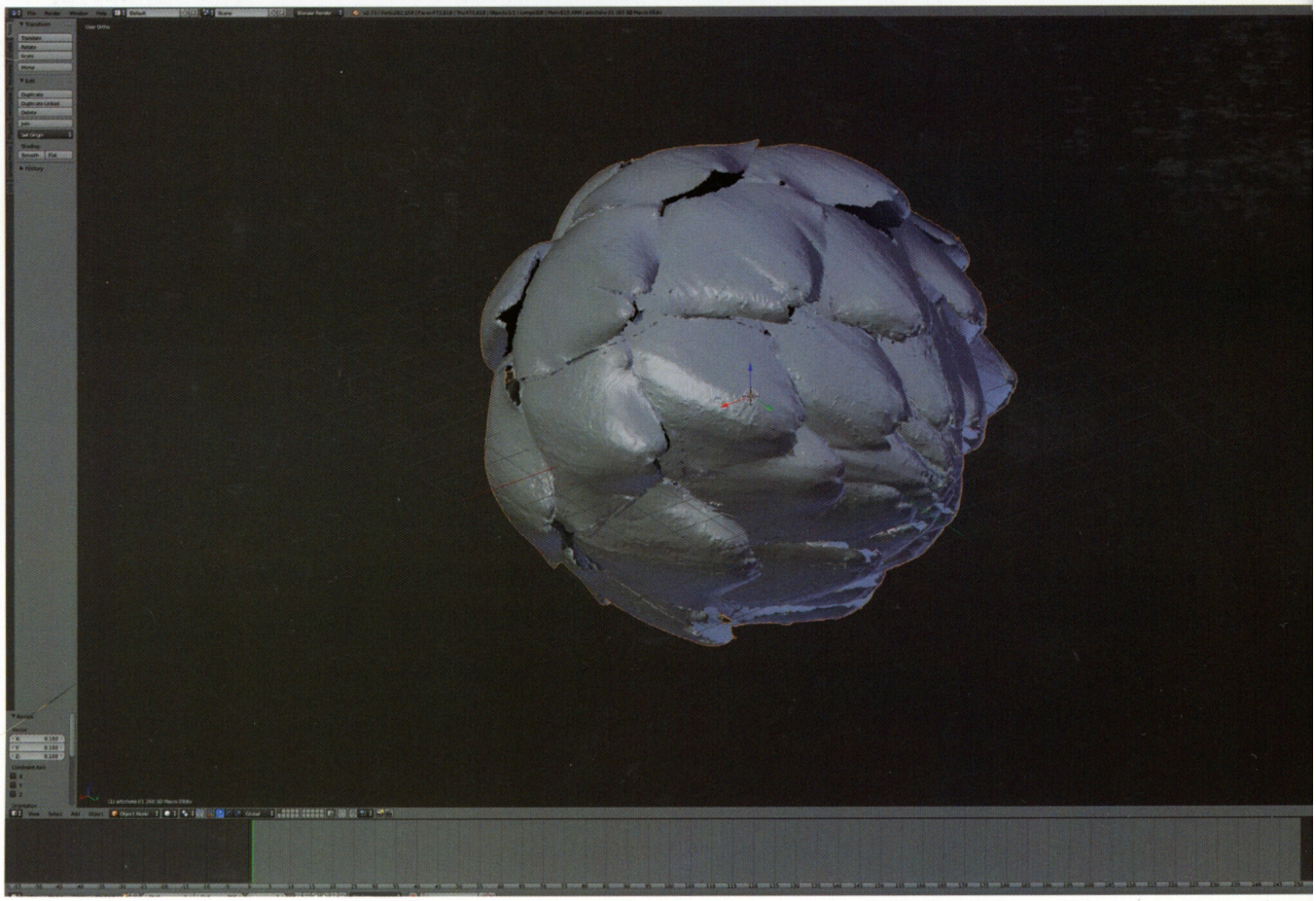


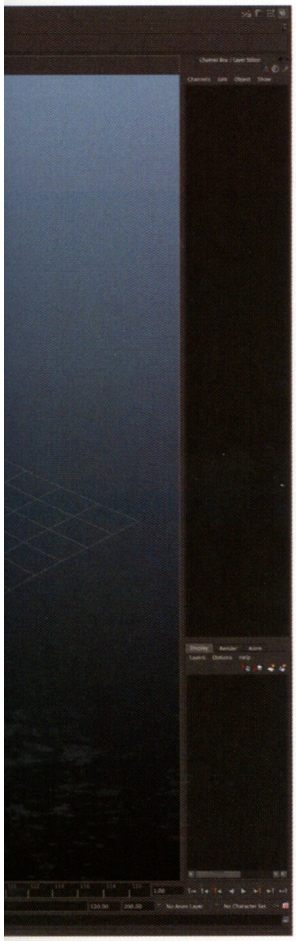
Shapeways porcelain print, STL file by authors, fired with clear glaze.



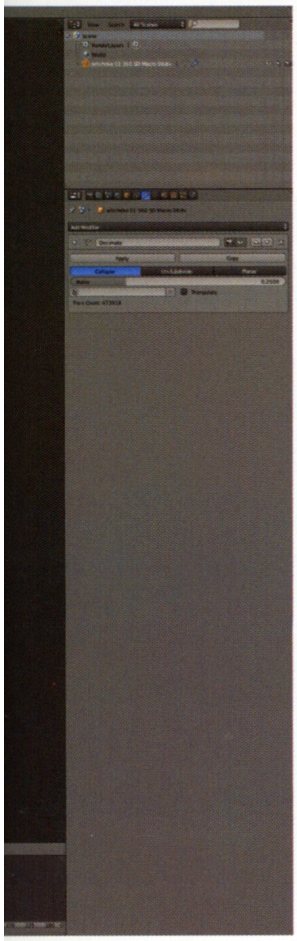
The abstracted, digital form of the clay object understands the ceramic artist through parameterization, becoming not just a form, but also a potential for a multitude of forms, and a multitude of materials.







Screen capture of the default Maya interface, showing how the software will typically look while working on a model. Compare to the Blender screenshot and note the difference in density of interface controls.



Screen capture of the default Blender interface, showing how the software will typically look while working on a model. The same model as pictured in the Maya screenshot is open for comparison.

Software

One of the most confusing things to a newcomer to the world of 3D fabrication can be the dizzying array of software available for 3D modeling, scanning, and editing. Often, the usefulness of a piece of software can be judged in large part by the size and activity of its community of users. By this metric Autodesk Maya© is an excellent choice. Maya is Autodesk's flagship, general 3D editing software, and it can be very useful for modeling a 3D object from scratch, or editing and preparing scanned objects. The downside is it is very expensive and its features go well beyond what would generally be needed by the ceramic artist. Another option, which has a much smaller but still very vocal and supportive community surrounding it, is open-source software called Blender from the non-profit Blender Foundation. It is available for free and has many of the 3D modeling and editing features that Maya has. Blender, with its more inviting interface, its price and perfectly capable feature set, makes for an attractive choice. For the specialized tasks of cleaning and preparing scanned objects for printing, there are some other options that are especially useful. Meshmixer, also from Autodesk, and Meshlab, an open source application developed mostly by students at the University of Pisa and supported by 3D-COFORM, are two additional free pieces of software specifically designed for that task.

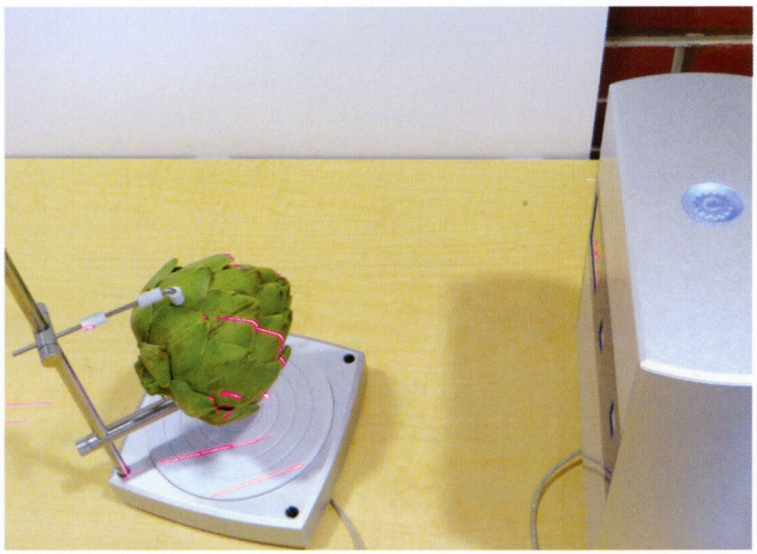
Scanning

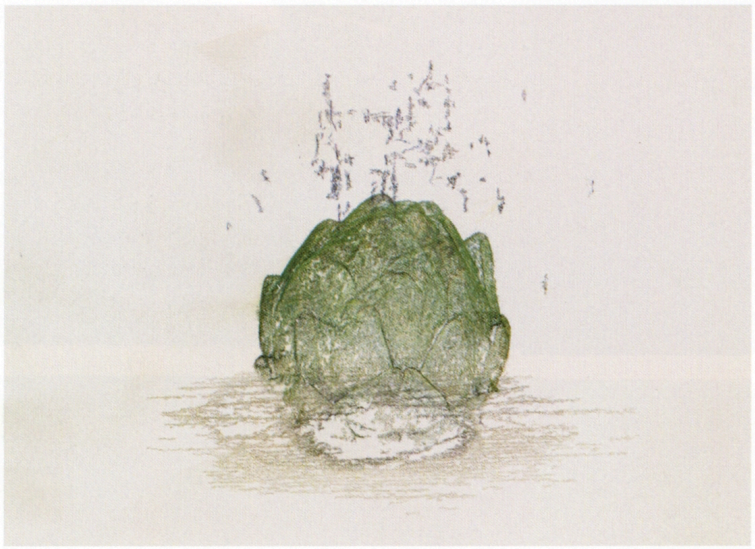
3D scanning is a powerful and accessible way to digitize physical surfaces as 3D models, which can be used to make 3D prints. It is a more object based approach to working with digital imagery, and can be interwoven with other methods of modeling. Autodesk 123D Catch© is a free 3D scanning app for your iPhone and iPad, as well as a web app, which can be used through a web browser. 123D Catch utilizes a technically accessible scanning technique called photogrammetry. In this process, a digital 3D surface is reconstructed from multiple photographs of a scene or object taken from various angles and positions. The app guides the user to capture 20-40 images at different heights and angles around an object. The photogrammetric process requires common points of contrast between these images to reconstruct the space. The uploading process, which takes 2D images and processes them into a 3D file, can take a long time, hours even. However, if high quality images are used, the results are amazingly detailed and crisp.

Another option for photogrammetry-based 3D scanning, also from Autodesk, is Autodesk ReMake. It is a more robust, industrial strength application compared to 123D Catch, aimed at more expert users. It does not guide the user through taking photographs, and instead reconstructs 3D surfaces from previously captured imagery. There is a free version available which limits the number of photographs that can be used for reconstruction, (effectively limits the possible detail in the resulting 3D model) as well as the variety of export formats.

In addition to Autodesk's software, there are open-source applications that allow more user control over the process. VisualSFM is one such application, which provides similar capabilities in comparison to 123D Catch.

Here we scanned a number of objects for printing using a Next Engine 3D Scanner2 to scan a pawpaw fruit to impressive results. The advantages to this scanner as compared to the Z Corp scanner used previously (see Ceramics Technical, 2010, No. 33, pp. 54-59) are many. One is cost with the new model Z Corp scanner about ten times the cost of the Next Engine. The Next Engine software is easier to use and interfaces well with other software programs. The other is convenience as the Next Engine is stationary and has its own mechanical turntable and light source.





1. Scan in process, Next Engine3D scanner.
2. Screen capture of a photogrammetric scan of an artichoke. At this point in the process, a "point cloud" has been generated from pixel data from a set of images. The next step is to connect the individual points together to create a continuous surface.

Printing

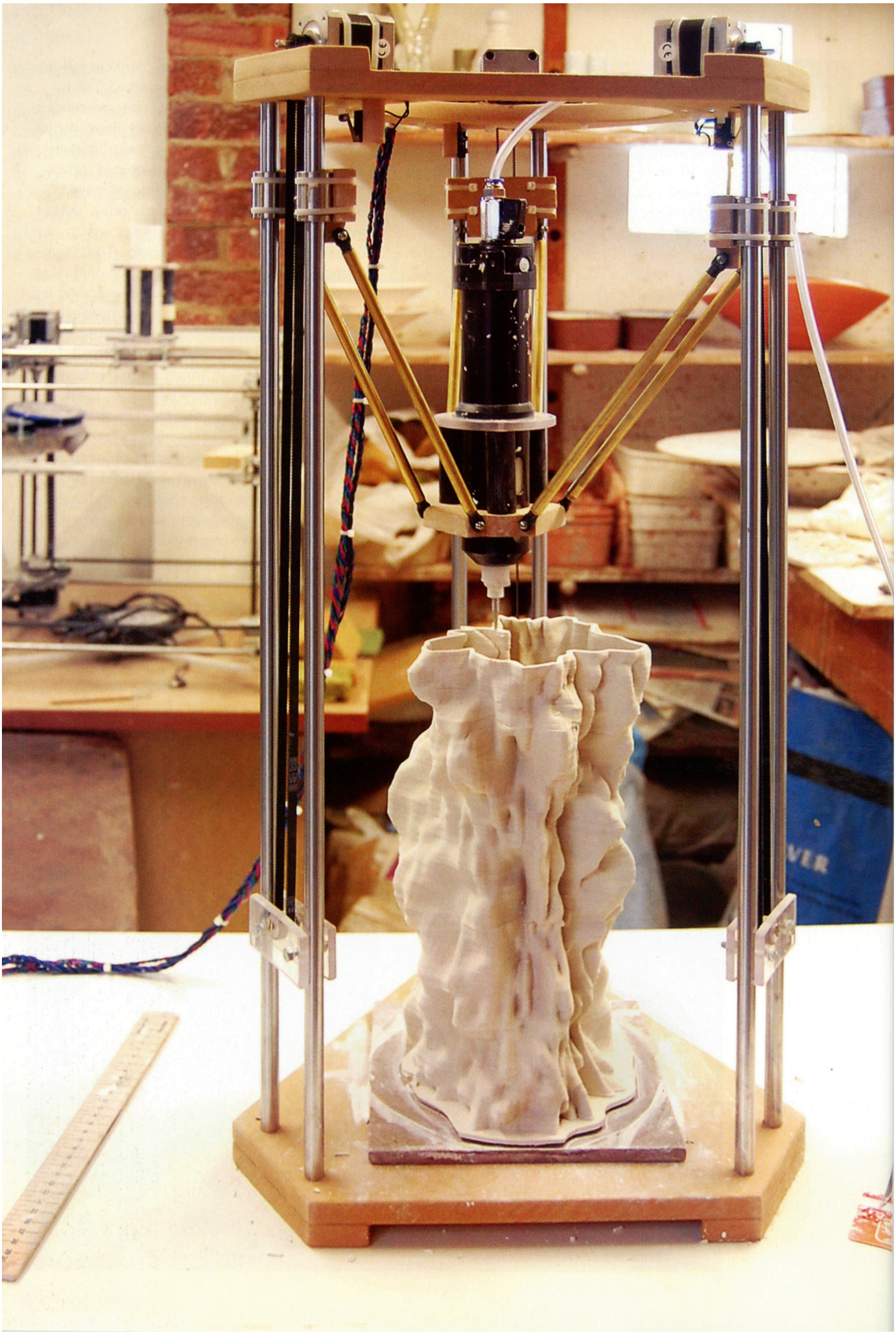
The next step, of course, is to print. Options for printing are thoroughly described in the article by Adile Feyza Çakir Özgündogdu, "3D Printing as a Forming Method," Ceramics Technical 2015, No. 40, pp. 8 - 15. Also, helpful in this clarification is a book titled 3D Printing for Artists, Designers and Makers, written by Stephen Hoskins, Hewlett Packard Professor of Fine Print and Director of the Centre for Fine Print Research at the University of West of England, Bristol, UK, reviewed in the same issue. To summarize for the sake of this article here are the three most often discussed:

1. UV cured photo-polymeric inkjet deposition, such as used by the Objet printer from Stratasys, prints a variety of plastics that make durable models for plaster molds;
2. FDM fused deposition modeling, used by Makerbot also from Stratysys, and Solidoodle, utilizes a heated head, extruding a thin strand of plastic that builds one layer at a time, and allows for the head to be converted to extrude clay (paste extrusion);
3. Powder binder 3D printing, used by Z Corp from 3D Systems, is a plaster based composite powder and binder, which can be converted to print a clay based powder instead.

There are also a few printing services called bureaus, which do printing on demand, eliminating the need for a personal printer and hassle of its maintenance of its inevitable obsolescence. A major bureau service is Shapeways. They can either design for you or you can upload your 3D STL file and go through a series of steps to have them print in a variety of materials. Once printed, you can actually sell your prints on demand through their marketplace. They have a long list of materials to choose from, including brass, castable wax, precious metals, sandstone, plastics and ceramics. The Shapeways website recently announced their new and revolutionary material with the headline reading, "The Polish and Poise of Porcelain." Our first trial print using this service shows some roughness on the bottom edge, but the glazed surface is very smooth. Unfortunately, many of the marks of the original STL file are smoothed over and so obliterated. Ironically, their process involved making a negative file and printing a 3D mold and then slip casting the porcelain, much like the process we currently use to create work.

One bureau, 3D systems, bought Figulu from developer Forrest Snyder. As with many things in this fast paced and ever changing field, 3D Systems shut down their ceramics printing business early in 2016. Since that time, Snyder have been working in his own studio 3D printing ceramics. He has done limited printing and is interested in printing work for others.

Vessel Collection, Kate Blacklock, tallest 18 in, 3D print, 3D Systems. Image credit: Mark Johnston.



As more people are getting involved and the tools of 3D printing mature, the art being done with it should advance as well and begin to find value in its own content, rather than leaning on the flashy, experimental perception with which 3D printing is frequently regarded.

One of the artists and curators Kate Blacklock, worked with Snyder to print pieces for an exhibition called HIfire RESolutions: 3D Printing in Clay. The exhibit included a number of artists that had not worked with 3D print previously and was held in conjunction with the National Council on Education for the Ceramics Arts Conference, March 19 - April 3, 2015, at The Chazan Gallery in Providence, RI. (NCECA Journal, Volume 36, 2015 pp. 56 - 57). The material that Snyder is using is high temperature whiteware. Blacklock felt the material improved from the time she started the project until the pieces were actually printed. Snyder felt that "this effort provided a great model for how to collaborate with artists and develop a business in fine art production. The collaboration allowed us to document and define the steps for an artist who wants to use 3D printing to expand their creative possibilities."

Tethon 3D is a bureau that specializes in ceramics 3D printing. They sell a proprietary binder and powder clay mix for the ZCorp printer, as well as offer print on demand services. Their website states, "We are part of this movement working to discover valuable uses for 3D printing, otherwise known as additive manufacturing. Our focus on ceramic material produces the best products and service for diverse industrial, medical and design industries." They have been working with ceramic artists John Balestreri and Chris Gustin to realize their work in 3D printing. Recently they have developed Porcelite© Ceramic Resin, a porcelain polymer resin for use with printers utilizing a UV light source for hardening to resin to make it solid in the desired shape, such as Formlabs Form 1 and 2 3D printers. Karen Lindner, President and CEO, describes the process that after the 3D print is removed from the printer, "it is cleaned in rubbing alcohol. It is then fired in a vented kiln to Cone 3 to burn out the polymer and transform it to 100% porcelain. It can then be glazed with commercial glazes, if desired. High fire glazes are recommended."

Today, it is not a stretch to find 3D desktop printers in artist studios. The majority of them are FDM paste extrusion type printers. Considerations in purchasing a desktop printer are print size, resolution related to speed, and of course price. They all have available compatible software, sometimes proprietary, or they use Repetier Firmware, which is free software used to drive printers.

According to Repetier's website, one does not need to be a programmer to install this firmware as it includes a step-by-step tutorial to configure it to match your personal printer. We have first hand experience with a Solidoodle© Printer, a rather inexpensive and compact printer. The main issues are related to the proper heat of the extruder tip and the printing bed as well as the speed of printing, all controlled with Repetier software. This takes a little time and patience while trying to print different types of files.

Jonathan Keep's 3D printer with piece from Iceberg series in process.

One of the more commonly found desktops is made by Makerbot®. The latest Replicator desktop printer costs just under $2,500 at time of publication. It can print detailed prints, reasonably priced with a variety of filament colors and effects, including glitter, wood chips, and numerous others. The process is basically coil building, and a smooth surface like one finds with the Objet is almost impossible to attain as the building process is evident in the final model. Interestingly, we are beginning to appreciate these digital markings and find an affinity to the mark of the hand.

Certain artists have been receiving a good deal of attention for their work in 3D printing in ceramics. One is Jonathan Keep, included in the Ceramics Technical article previously noted, uses a DIY FDM printer converted to extrude clay. He calls this method of working "The Fourth Way," a new way of making in clay. He does not use modeling software to create his forms. Instead, he uses computer code and feels this brings him to a better understanding of the material. He is interested in the relationship of the computer code to mimic nature. Keep has thrown on the wheel for years. His digital work builds with coils, yet he rhetorically asks if we can call it hand-building. To often I see digital research projects that do not go anywhere as they have little relevance other than the challenge of getting them done. The success will be when they become part of tradition.

Michael Eden describes himself as "a maker whose work sits at the intersection of craft, design and art, exploring contemporary themes through the redesign of historical, culturally familiar objects utilizing digital manufacturing and materials." A potter from England and with an MPhil from the Royal College of Art, he used his time there researching and exploring his interest in digital technology and how he might combine those skills with his skills as a potter.

His first 3D printed piece titled, The Wedgwoodn't Tureen, was printed with non-fired ceramic materials. He redesigned an iconic object from the first Industrial Revolution in a way that would likely be impossible manually. Eden states, "Many people, and this includes many of my colleagues from the studio pottery world, think that 3D printing simply happens by 'pressing the button,' but through my works I hope to demonstrate that the new tools I use require the acquisition of new craft skills and thought processes."

Recently, Eden worked with Tethon 3D to print a piece in Porcelite, titled Arita. This vessel is based on some pieces that were designed with Rhino3D CAD software and previously printed in nylon by Selective Laser Sintering (SLS). Eden states, "I chose this piece as I knew it would be a challenge for Tethon 3D, as it not only has a complex pierced structure, but a narrow section between the pedestal and the bowl. From my previous experience of printing ceramic powders, I knew that there was a large chance that the piece would warp badly if printed in one piece, so it was printed in sections and assembled before firing. I regard this piece as a successful experiment, but only as a step along the way to being able to reliably print my work directly in ceramic materials.

GSOH, 2015, Michael Eden, unique object made by Additive Layer Manufacturing from nylon with a dark blue mineral coating. 15 ¾ x 8 5.8 in. dia. Image credit: Adrian Sassoon, London.

Model printed with Objet on left, model printed with Makerbot, on right.

Ceramic artist and designer Jeff Kell worked with Snyder while with Figulo. Kell states, "I designed this piece in Autodesk Alias Design, a software I've been using for 20 years. It allows for the creation and manipulation of complex detailed surfaces and export of STL data for printing. In this instance I chose ceramic 3D printing rather than hand-building for two reasons. First, I wanted to work small, second, I wanted to produce a limited edition."

In his book, Stephen Hoskins states, "... the real test comes when the objects transcend the process involved." Currently, he feels they are "subservient to the process2." It is hard to argue with him, yet there is promise in the work of these and other artists. For now, much of the artistic work being done with 3D printing remains driven largely by the novelty of the technology. As more people are getting involved and the tools of 3D printing mature, the art be done with it should advance as well and begin to find value in its own content, rather than leaning on the flashy, experimental perception with which 3D printing is frequently regarded. It is at that point that these tools will show their true worth as an addition to the ceramics artists' toolbox.

Bloom, 2015, Jeff Kell, 8 x 6 x 6 in., 3D printed ceramic, glazed and fired to cone 10 with additional low temp firing and post firing treatments. Image credit: Geoff Tesch.

Anna Calluori Holcombe: Digital Integration in a Ceramics Practice

My recent work is based on research and published article in 2010 Ceramics Technical, No. 33, pp. 54-59, co – written with Daniel Tankersley. I have relied on a two-way collaboration between myself and Digital Media artists to create this work. Currently, my research continues to rely on the collaboration between Thomas Storey and I, with a focus on more affordable and easier to use software and hardware. We believe that these technologies are available and accessible to the ceramic artist today.

When I travel and explore the world, I cannot help but make connections. Nature is one place that I look for these connections. Interestingly, the word nature has multiple definitions, ranging from a person's inherent character to an organ's function and to the flora and fauna found in the landscape. I scan natural objects and make models to cast in plaster for slip casting with porcelain. At this stage I make the connection of the model to the clay object. Despite the use of this technology, I do a great deal of hand work cleaning, connecting, glazing, finally using decals and china paints. My current works continues the Piante series, building in an assemblage fashion to create the arrangement. In these pieces I use LED lit pedestals to accentuate the translucent qualities of the porcelain and cast glass, adding the elements of light and shadow to the composition. By taking natural objects and using them in a digital form creates a juxtaposition that I find interesting, suggesting a relationship between the forms that takes on the genre of the still life.

Coming out of this recent research I have begun to explore printing with ceramic materials directly. And as I continue to explore 3D technologies and how I might use them in my work, I have been increasingly interested in digital mark making of the process and plan to further connect the two. ■

Piante 46, 2014, Anna Calluori Holcombe, porcelain, 3D scanned and printed models, slip cast, kiln cast glass, 5 x 15 in. dia. Image credit: Alan Cheuvront.

Resources

www.forrestsnyder.com
www.formlabs.com
www.blender.org
www.meshmixer.com
www.meshlab.sourceforge.net
www.123dapp.com/catch
www.wikipedia.org/wiki/photogrammetry
www.makerbot.com
www.shapeways.com
www.tethon3d.com
www.repetier.com
www.kateblacklock.com
www.keep-art.co.uk/digital.html
www.michael-eden.com
www.jeffkell.us
www.remake.autodesk.com/about

References

"New Models for Ceramics: 3D Technology, Two Views," written with Daniel Tankersley, Ceramics Technical, No. 33, 2011, pp. 54 - 59
"3D Printing as a Forming Method," Adile Feyza Çakir Özgündogdu, Ceramics Technical, No. 40, 2015, pp. 8 - 15.

Bibliography

1. Power Of Making, The Importance Of Being Skilled, edited by Daniel Charny, V&A Publishing and the Crafts Council, England, 2011, p. 49.
2. 3D Printing for Artists, Designers and Makers, written by Stephen Hoskins, Bloomsbury, Publishing Plc., London, 2013, p. 62.

About the authors

Anna Calluori Holcombe is a Professor at the University Of Florida, Gainesville. Her research involves 3D printing technologies. She is a member of the International Academy of Ceramics. www.annaholcombe.com
Thomas R Storey is a digital media artist and a MFA graduate of the University of Florida. He uses computer graphics and network technologies to investigate mediation, perception and the real. www.thomasrstorey.net