Listening to materials. I mean, really listening...

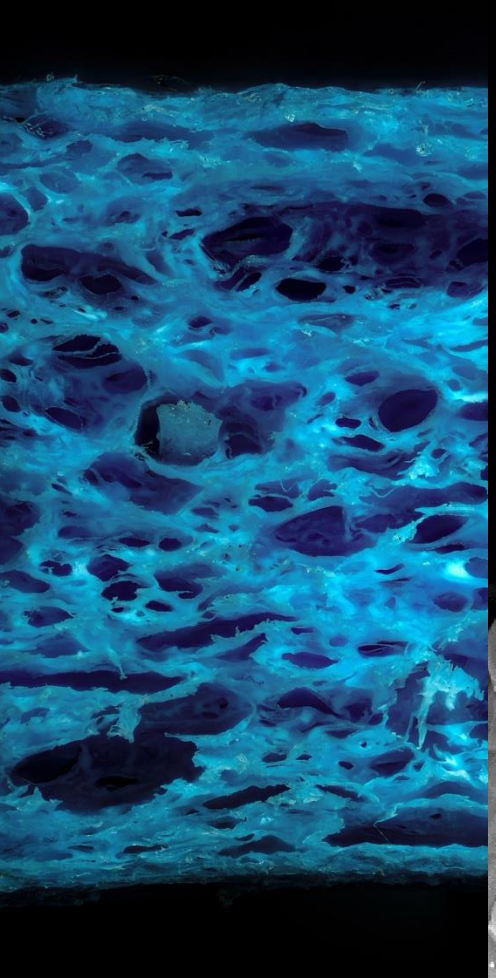
Timea Tihanyi
University of Washington / Slip Rabbit Studio

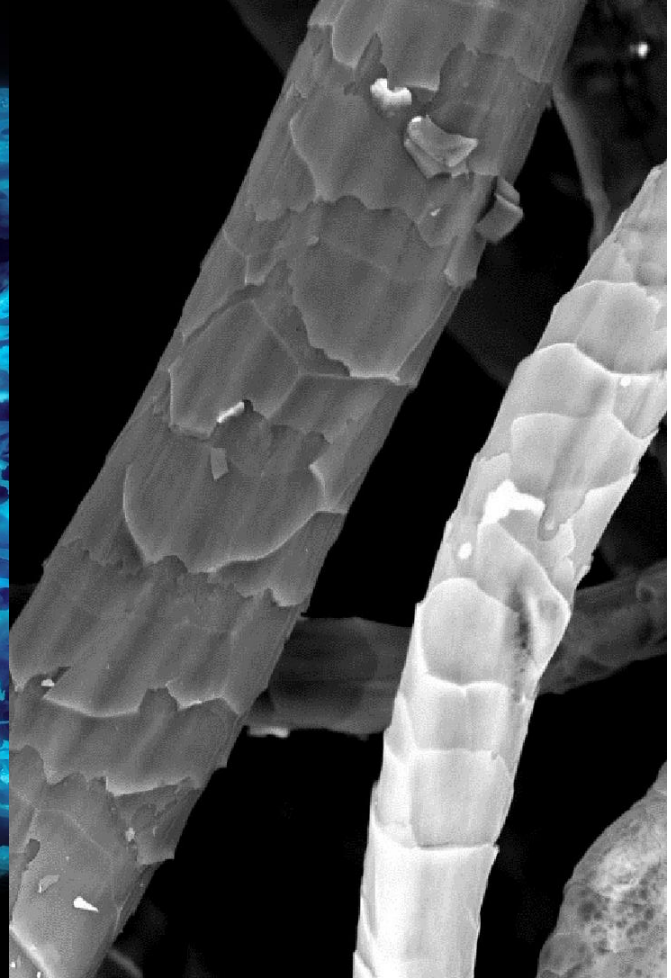
Listening to materials. I mean, really listening...

Throughout history, societies have discovered and developed materials, made tools and artefacts from them and, in doing so, constructed *themselves* in the process.

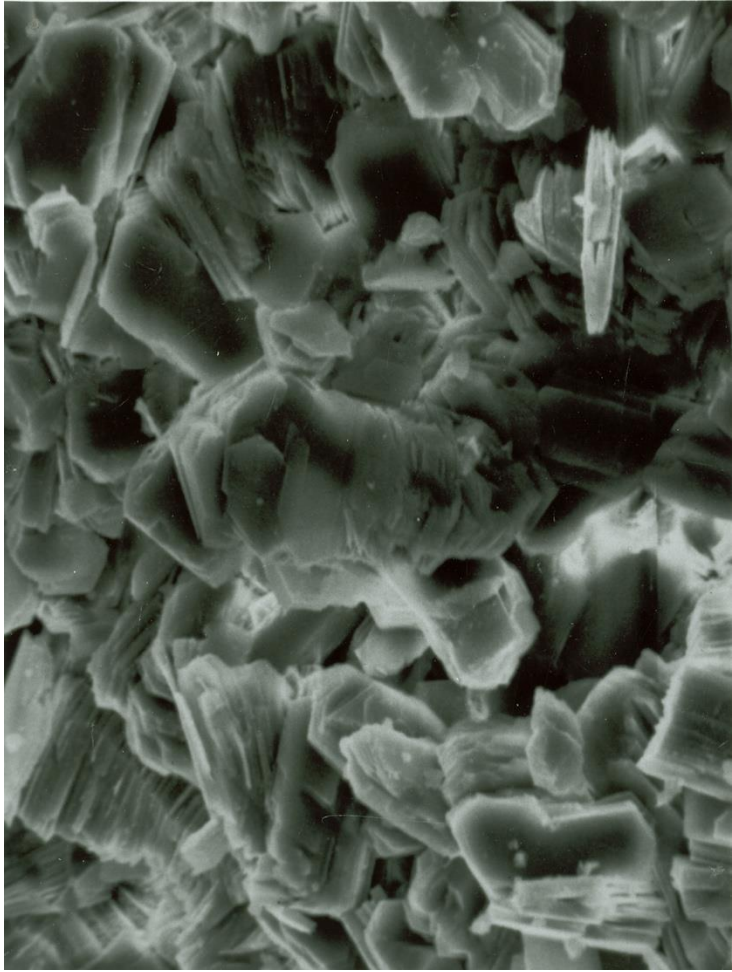
Complexity at this order of magnitude defies any single way of knowing. Rather, it necessitates an array of techniques, from computational modeling and measuring, to experimental trial and error, to sensing and observation.

Liz Corbin, material researcher and designer, Institute of Making, University College, London





Cellulose and wool fibers under scanning microscope



Kaoline (Ceramic platelets)

What is clay?

Al_2O_3 (Aluminum Oxide, Alumina)
Refractory agent

SiO_2 (Silicon Dioxide, Silica)
Glass forming agent

And other mineral components

C Kaolin

Oxide	Analysis	Formula
CaO	0.03%	-
K2O	3.30%	0.11
MgO	0.14%	0.01
Na2O	0.07%	-
TiO2	0.19%	0.01
Al2O3	32.68%	1.00
SiO2	52.60%	2.73
Fe2O3	1.33%	0.03
LOI	9.66%	n/a
Oxide Weight		281.97
	Formula Weight	312.12

C & C Ball Clay

Alternate Names: C&C Ball Clay, C and C Ball Clay

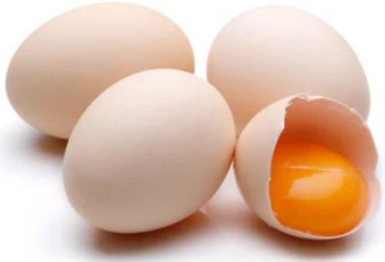
Description: White burning plastic ball clay

Oxide	Analysis	Formula
CaO	0.10%	0.01
K2O	0.41%	0.02
MgO	0.20%	0.02
Na2O	0.20%	0.01
TiO2	1.64%	0.08
Al2O3	26.29%	1.00
SiO2	59.84%	3.86
Fe2O3	0.92%	0.02
LOI	10.40%	n/a
Oxide Weight		347.63
	Formula Weight	387.98

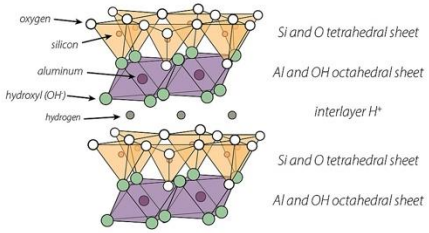
Wikimedia Commons

Mullite is the mineralogical name for the only chemically stable intermediate phase in the SiO_2-Al_2O_3 system. The mineral rarely occurs in its natural form and can be found on the Isle of Mull off the western coast of Scotland.

What is clay?

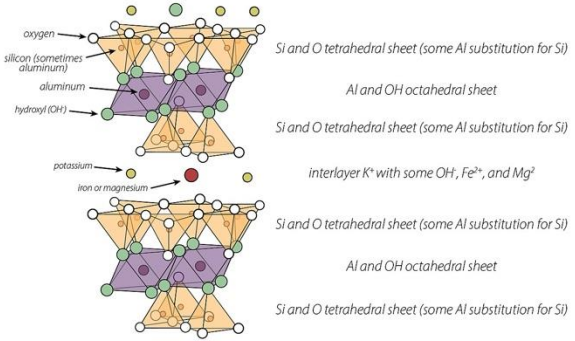


Kaolinite group (1:1 clays)



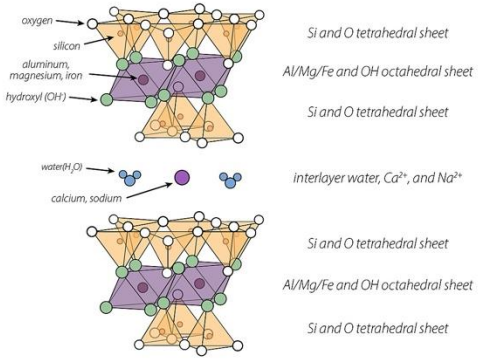
includes kaolinite, it's polymorphs, and the hydrated form halloysite; common in areas with intense weathering and/or Al-rich parent

Illite (2:1 non-swelling clays)



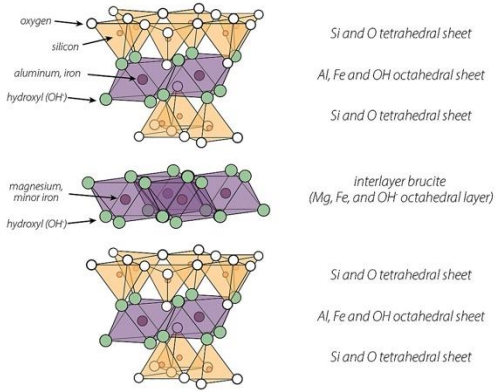
strong bonds in the interlayer potassium prevents swelling; found in temperatue climates as the weathering produce of mica and feldspar

Smectites (2:1 swelling clays)

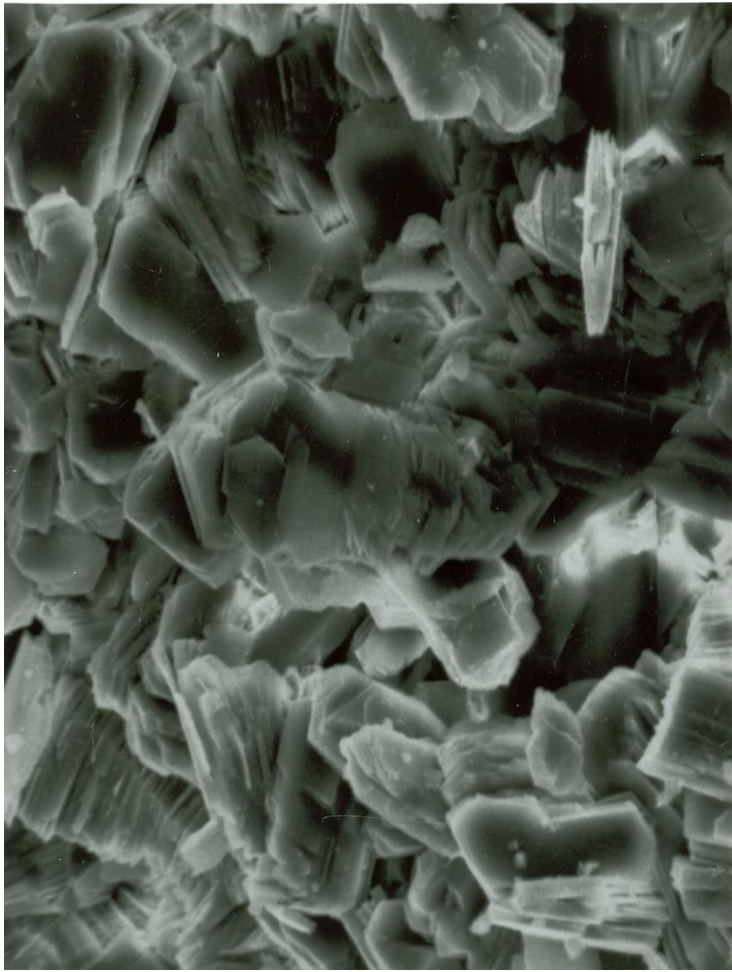


swelling clays including bentonite, montmorillonite, and vermiculite - closely associated with glauconite (abundant Fe in octahedral sheet); most commonly in temperate and arid climates, forms from weathering of volcanic ash, basalt, gabbro, and other Fe- and Mg-rich parent rock

Chlorites (2:1:1 clays)



non-swelling clays - gives low temperature metamorphic rocks a green color; typically associated with high latitude regions with Fe- and Mg- rich parent rock



Kaolinite. (
Hydrous aluminium phyllosilicate $Al_2Si_2O_5(OH)_4$

Clay particles were found to be predominantly sheet silicate (phyllosilicate) minerals, now grouped together as clay minerals. Their structure is based on flat hexagonal sheets.

Earliest known (crafted) artifacts of fiber and ceramic materials

30,000-Year-Old Wild Flax Fibers

Eliso Kvavadze,[1] Ofer Bar-Yosef,[2]* Anna Belfer-Cohen,[3] Elisabetta Boaretto,[4] Nino Jakeli,[5] Zinovi Matskevich,[2] Tengiz Meshveliani[5]

Here, we report an identification of wild flax fibers from a series of Upper Paleolithic layers at Dzudzuana Cave, Georgia (*1*, *2*), indicating that prehistoric hunter-gatherers were making cords for hafting stone tools, weaving

We found the flax fibers during analyses of 86 clay samples of 50 g each collected from five locations within the excavated area in 2007 and 2008 (table S2). The clay deposits are rich in carbonate and produced large amounts of nonpollen palynomorphs, including microfossils of fungi, algae, cormophytes, and animal hair. The flax fibers were present throughout the sequence with a peak in the early stages of unit C. Although climatic fluctuations are recorded through the depositional sequence, flax plants could likely have survived in the immediate environment of the cave during its habitation.

A few of the fibers are colored and appear to have been dyed. A wide range of natural pigments was available to the Upper Paleolithic occupants of the cave, including roots and other plant parts (*5*). The color range includes yellow, red, blue, violet, black, brown, green, and khaki.

All 27 clay samples from unit D produced fibers of flax (N = 488) (table S2); some were spun (N = 13) and dyed (N = 58), the colors are mostly black-to-gray and turquoise. One of the threads is twisted. The complete fibers are long (>200-m) and composed of segments of smaller lengths. Individual fibers are linear with thin and translucent walls. Several ends of both complete and disbanded fibers were cut across (Fig. 1, 1 to 7).

We recovered 787 fiber fragments of various lengths from unit C. The highest concentration was in sublayer C-5 (table S2). A few fibers were spun (N = 18), and one string had numerous knots (unit C-3). We found 38 colored fibers: black, gray, turquoise, and a pink one.

Fewer flax fibers were found in all seven samples of unit B (N = 48; only three of which were colored, one black and two turquoise) and in five samples of unit A (N = 30) (table S2).

Several samples from unit C appear to be two-ply S-twisted in a relatively complex pattern (Fig. 1, 8 to 12). The colored fibers may indicate that the inhabitants of the cave were engaged in producing colorful textiles. We also recovered a few tur hairs in unit D, including colored and twisted ones (fig. S1). The combination of flax fibers, some tur hair, and microremains of skin beetles (fig. S2) and moth can be interpreted as an evidence for processing of fur, skin, and cloth. This conclusion is supported by the presence of spores of the *Chaetomium* fungus (fig. S2), usually growing on clothes and other textiles and unfortunately destroying them (*6*).

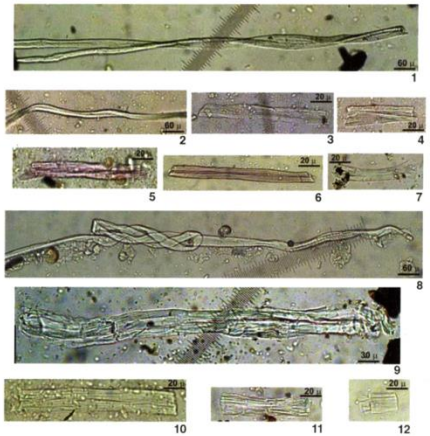


Fig. 1. (**1** to **7**) Fibers from Dzudzuana, Georgia, unit D. 1, twisted flax fibers; 2 to 4, flax fibers; and 5 to 7, unraveled flax fibers. (**8** to **12**) Fibers from Dzudzuana, unit C. 8 and 9, twisted flax fibers; 10 and 12, flax fibers; and 11, dyed flax fibers.

baskets, or sewing garments. Other reports of the early use of plant fibers include Dolni Vestonice (Czech Republic) at ~29 to 32 thousand years ago (ka) (probably nettle, *Urtica* sp.) (*3*) and unidentified species in Ohalo II (Israel) at ~21 ka (*4*).

Radiocarbon dates demonstrate that Dzudzuana Cave was inhabited in the Upper Paleolithic period, during 32 to 26 ^{14}C years before the present (yr B.P.) [36 to 31 thousand years ago (ka); unit D], 23 to 19 ^{14}C yr B.P. (28 to 24 ka; unit C), and 13 to 11 ^{14}C yr B.P. (15.5 to 13 ka; unit B), capped by Late Neolithic/Eneolithic deposits of unit A (6.3 to 5 ^{14}C yr B.P.; 7 to 6 ka) (*1*) (table S1).

References and Notes

1. T. Meshveliani *et al.*, in *The Early Upper Paleolithic Beyond Western Europe*, P. J. Brantingham *et al.*, Eds. (Univ. of California Press, Berkeley, 2004), pp. 129–143.
2. Materials and methods are available as supporting material on *Science* Online.
3. J. M. Adovasio *et al.*, *Archaeol. Ethnol. Anthropol. Eurasia* **2001**, 48 (2001).
4. D. Nadel *et al.*, *Curr. Anthropol.* **35**, 451 (1994).
5. A. A. Grossgeim, *Rastitel'nye resursy Kavkaza* (*Plant Resources of the Caucasus*) (The Academy of Sciences of Azerbaijan SSR Press, Baku, Azerbaijan, 1946).
6. B. Van Geel, A. Artroot, *Nova Hedwigia* **82**, 3 (2006).
7. The American School of Prehistoric Research, Peabody Museum, Harvard University, funded this project; J. P. Wild helped in the identification of flax, cotton, and wool fibers; D. Lordkipanidze, I. Koridze, and G. Bar-Oz provided assistance; and D. Pilbeam, C. Bretine, and anonymous reviewers provided valuable comments.

Supporting Online Material

www.sciencemag.org/cgi/content/full/325/5946/1359/DC1
Materials and Methods
Figs. S1 to S4
Tables S1 and S2
References

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10.1126/science.1175404

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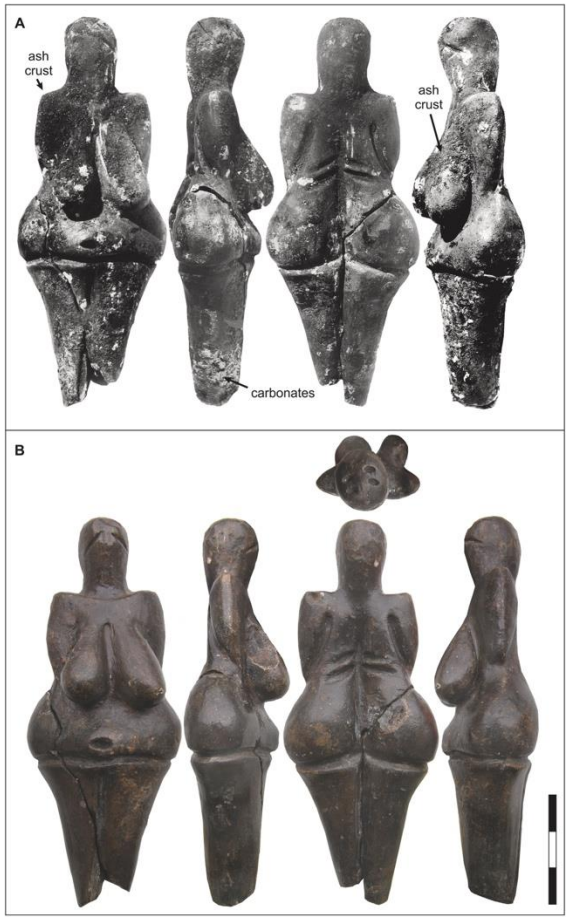


Flax thread possibly used for sewing or weaving
Dzudzuana Caves, Georgia
30 000 years old

Ceramic/loess/microfossil matter composite figurine
"Venus of Dolní"
Věstonice, Czech Republic
Gravettian culture
25-30 000 years old

Deep Vessel

Japan

Middle Jōmon period (ca. 3500–2500 BCE)

Not on view

Cord-marked pottery is the characteristic ware of the earliest inhabitants of Japan. These Neolithic people, known as the Jōmon (cord-marking) culture, existed on the abundant fishing and hunting on the Japanese islands from at least the fifth millennium B.C., surviving in some areas until the third century A.D. During this period handmade utilitarian wares were treated with inventive, often extravagant artistry, and regional separations between groups resulted in a wide range of types and styles. This earthenware food vessel, which came from the Aomori Prefecture in northeastern Japan, is remarkable for the fine quality of its clay and its sophisticated decoration. The cord-marked herringbone pattern was reproduced by cords knotted together and twisted in opposite directions.

Show me your inspirations and I know who you are.

Object DNA in 9 designer archetypes
The Fundamentals exhibition 2017 Dutch Design Week, Eindhowen
Dutch Invertuals with Raw Color

Tactile (Personal) Relationship

Archaeological finds from Izmir, Turkey (thought to be from a pottery workshop). 8000 years old.

Container of Memory

Camillo Rusconi 1700's
Putti Bearing Palms
Collection of Harvard Museums

Cultural History (Politics of materials)

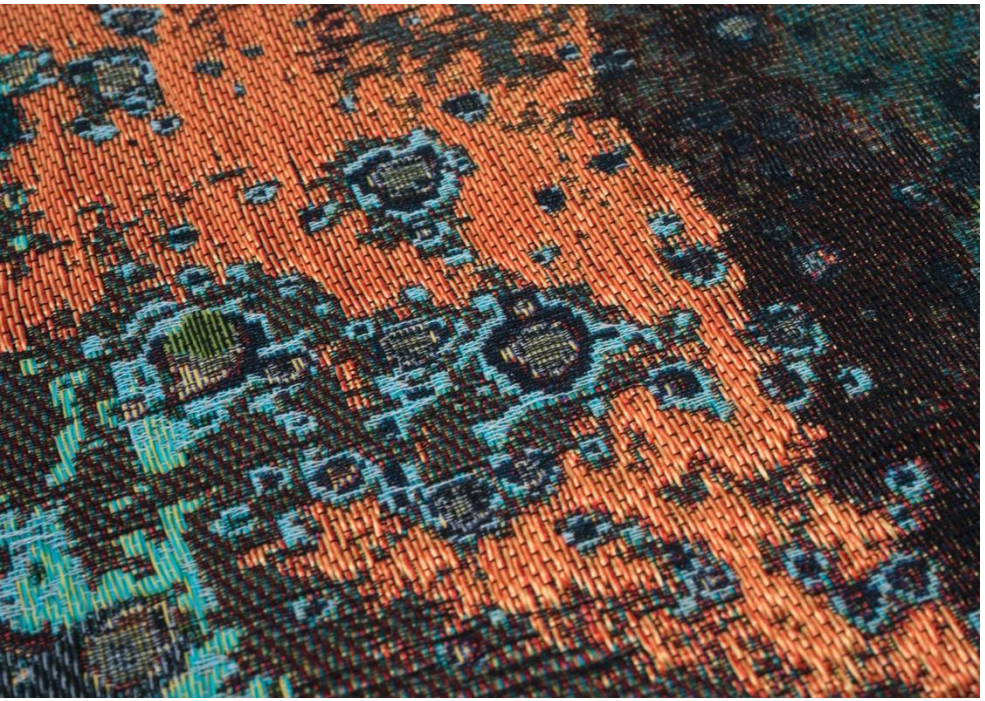
Anni Albers weaving at the Bauhaus

Magdalena Abakanowicz
Abakans
1967–1968

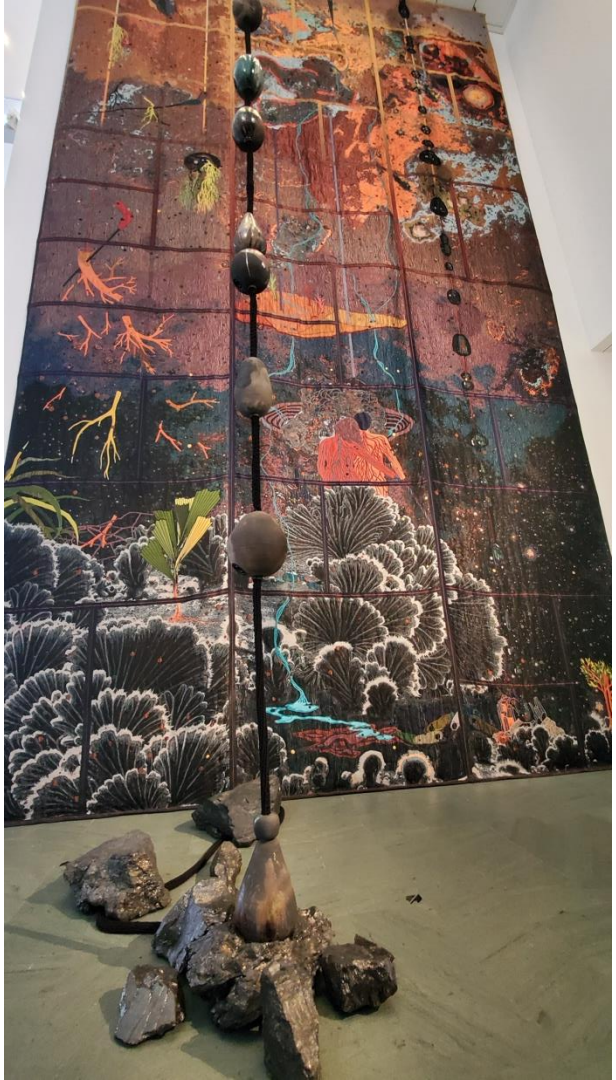
Sheila Hicks, The Evolving Tapestry: He/She. 1967–1968

Lenore Tawney, Dark River. 1962

“Textile is a universal language. In all of the cultures of the world, textile is a crucial and essential component”



Otobong Nkanga
Cadence
Museum of Modern Art, NY
2025



Hella Jongerius
Seamless Loom

Unfoldable Cubes
2021

Tradition and Innovation

Leah Buechley's Hand and Machine Lab at the University of New Mexico

HAND AND MACHINE

ABOUT PROJECTS PEOPLE PUBLICATIONS MORE

EXPERIMENTAL CLAY RESIDENCY 2023

Jeff Suina worked on a series of forms that integrate Cochiti Pueblo pottery traditions with digital design and 3D printing. Above: a form is designed in Blender, a 3D modeling software, 3D printed, then smoothed and painted by hand.

Monica Silva-Lovato worked on a series of computationally design and 3D printed artifacts. Above: a form is computationally designed, sliced with the lab's WeaveSlicer software, 3D printed, shaped by hand and then pit fired. This pot won a first place award at the Santa Fe Indian Market in the Boundary Category and was the first ever 3D printed pottery shown at the prestigious Native art and craft market.

Sustainability

Nienke Hoogvliet

sea algae yarn, knotted by hand in an old fishing net

Officina Corpuscoli

Growing a MarsBoot (Mycelium)

Tessa Silva-Davson

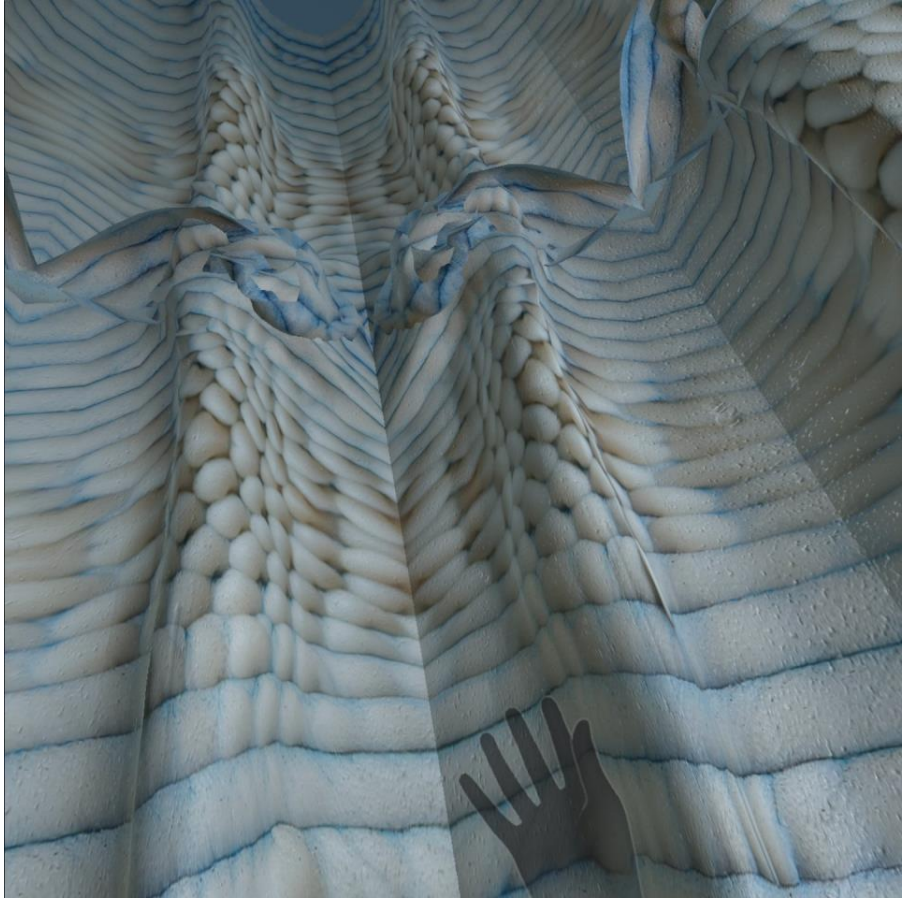
Milk Plastic (casein)

So, what do I do and why am I showing you all this?

Parlor Games: Scientia
Linda Hodges Gallery
Slipcast and carved bone china

Tender, 2023
Installation at the
Greg Kucera Gallery
3D printed porcelain

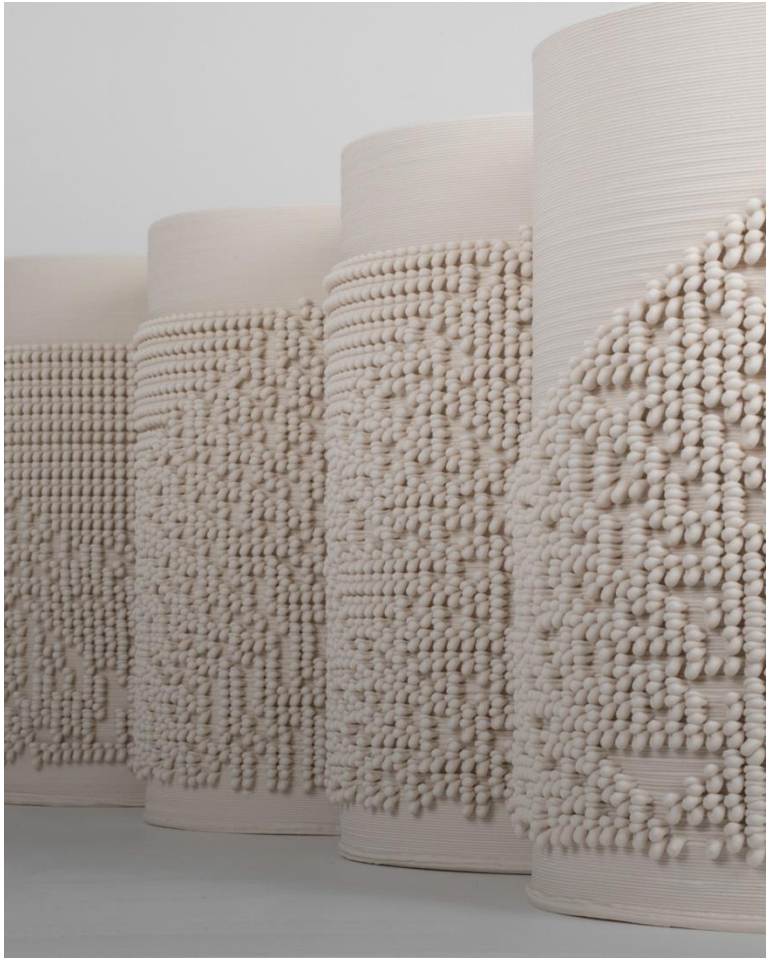
Mothering II. 2018
3D printed porcelain, mold-blown glass, elastic cord, concrete. 28”x18”x14”



Touching Space
Work in progress
Human-Responsive Virtual Reality Space

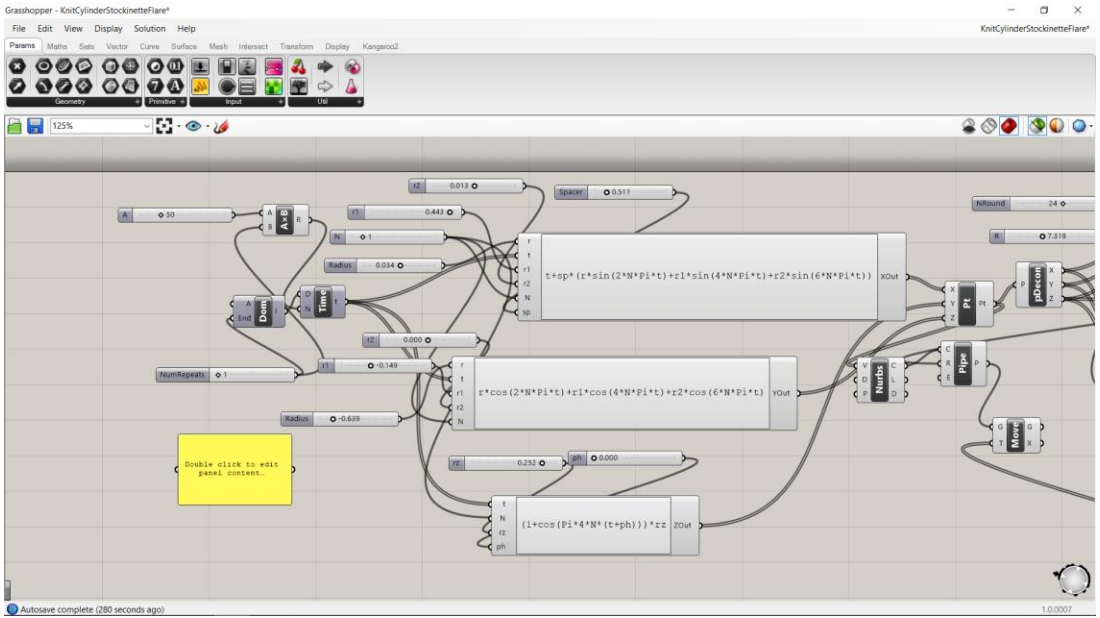
WASP40100 ceramic 3D printer at Slip Rabbit Studio

Loop tests at Slip Rabbit Studio. 2017

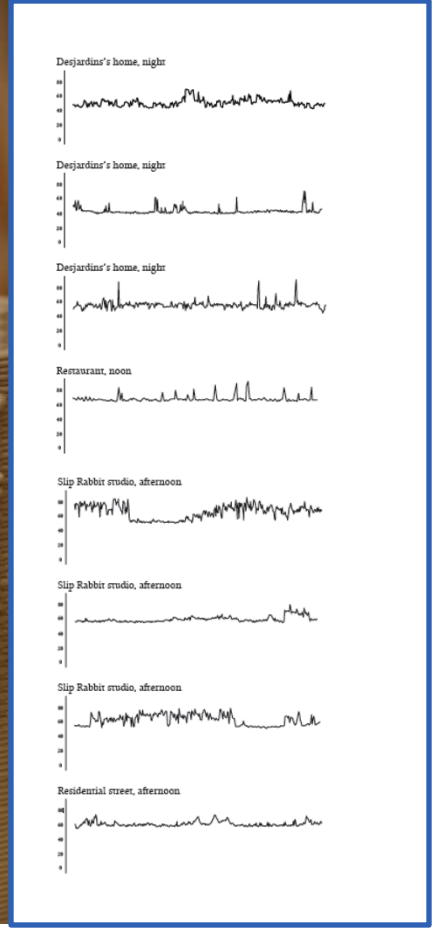


Burst and Follow series. 2018
3D printed porcelain. Based on the Elementary Cellular Automata.
CoCalc coding in collaboration with Sara Billey.

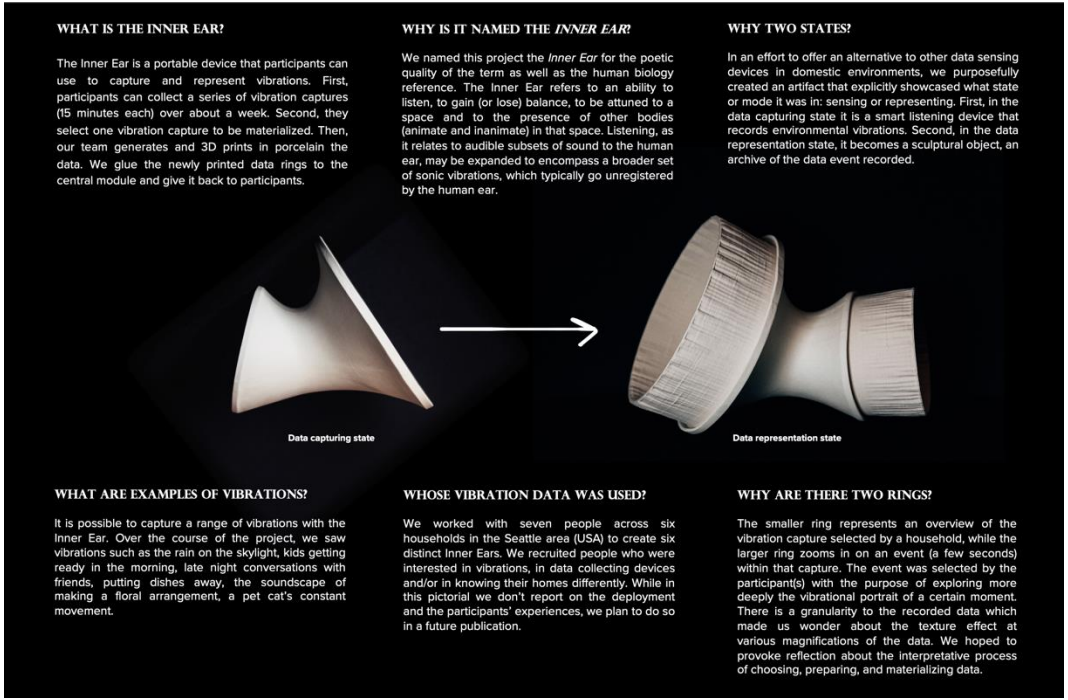
Control and Release. 2018
Installation with hand-cut vinyl and 3D printed porcelain based on the mathematical model of the elementary cellular automata



Grasshopper+Rhino
Knitting with Fourier series
Collaboration with mathematician Frank Farris

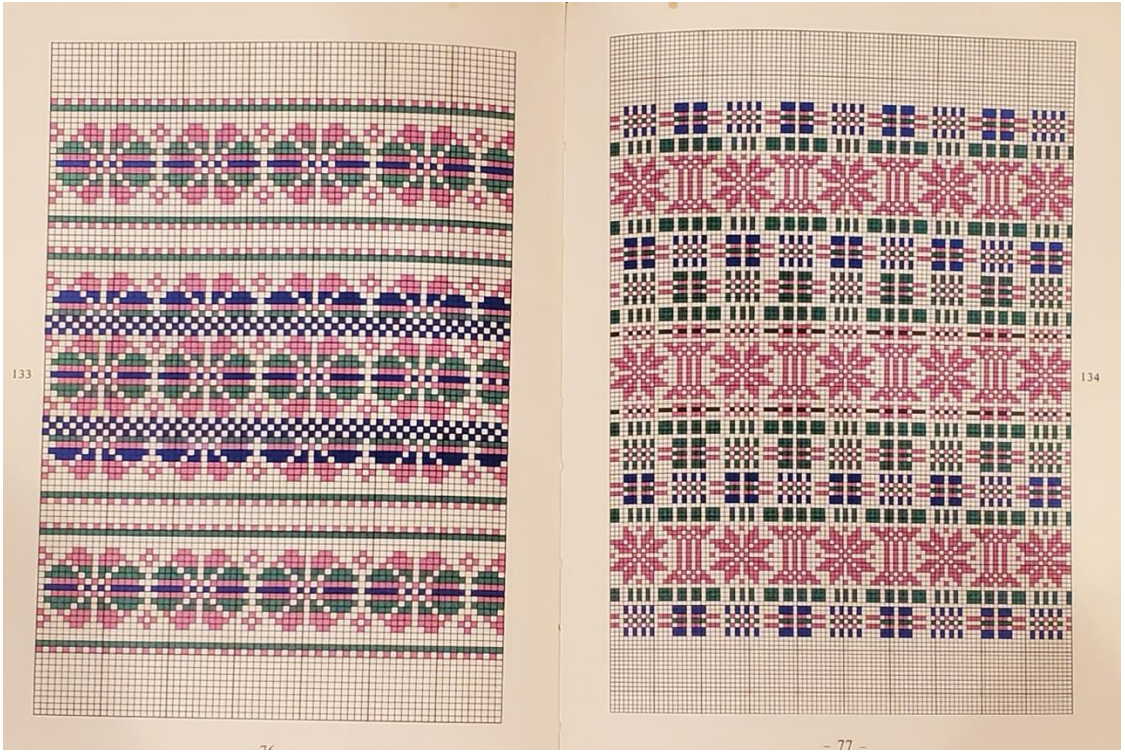


ListeningCups
Data physicalization.
Collaboration with UxDesigner Audrey Desjardins.

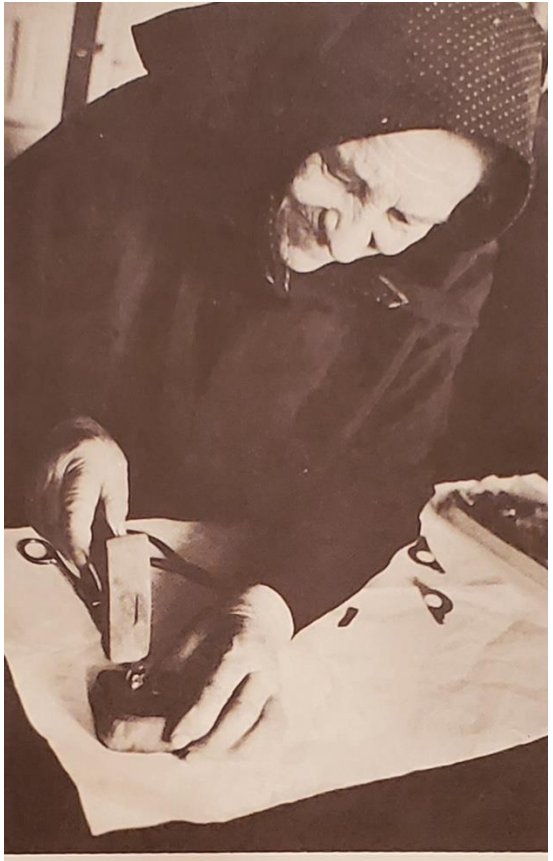


Inner Ear. 2022-23
3D printed porcelain device that captures and embodies home vibration data.
Collaboration with UxDesigner Audrey Desjardins.

Selbu Knitting Patterns from Norway.



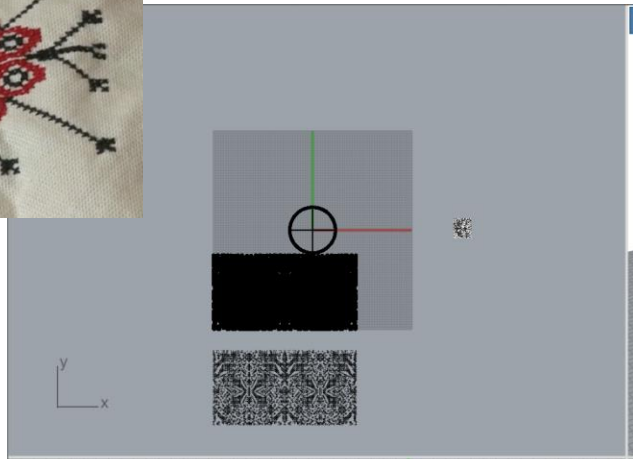
Cross stitch embroidery patterns from Somogy, Hungary.

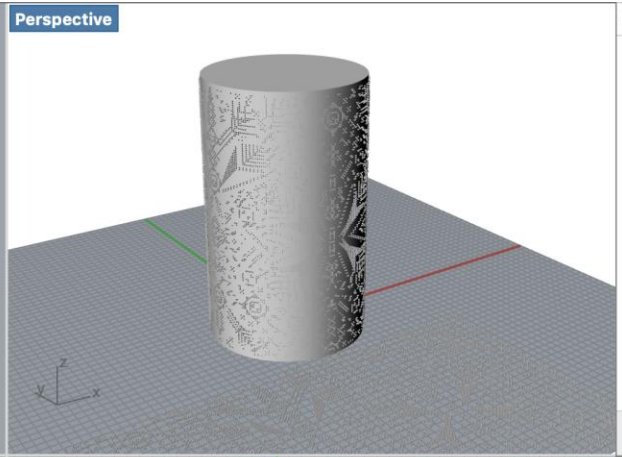


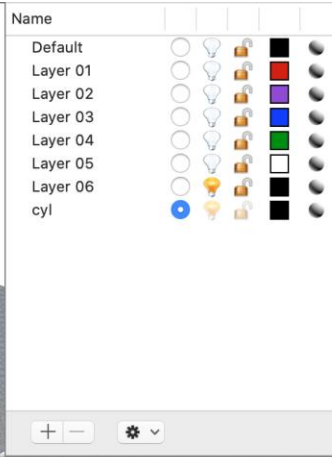
5. A meghajlított rézlemez beütése kalapáccsal. 1974.

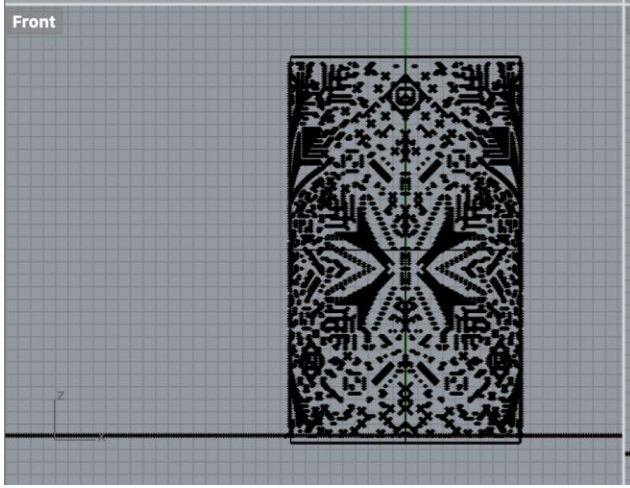
12. A mester és tanítványai hímeznek. 1974.

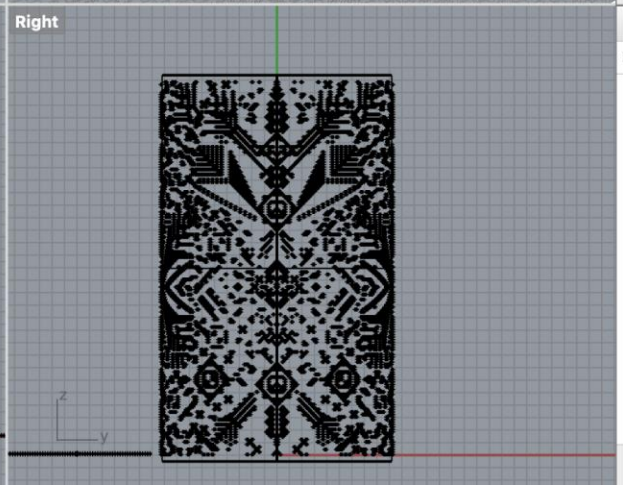
Traditional Hungarian cross-stitch embroidery

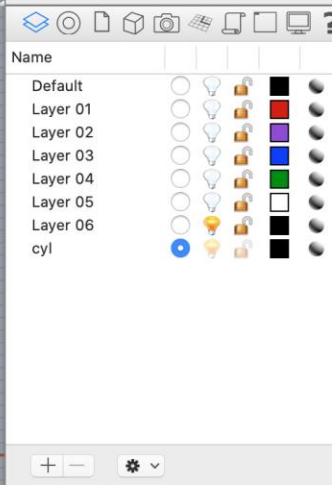












NorthStar Series
3D printed porcelain, pigments, glaze
9.5”x9.5”x9.5”

Tulipán Világom (My Tulip World) II.
2020
3D printed porcelain, pigments glaze
13"x11"x10"

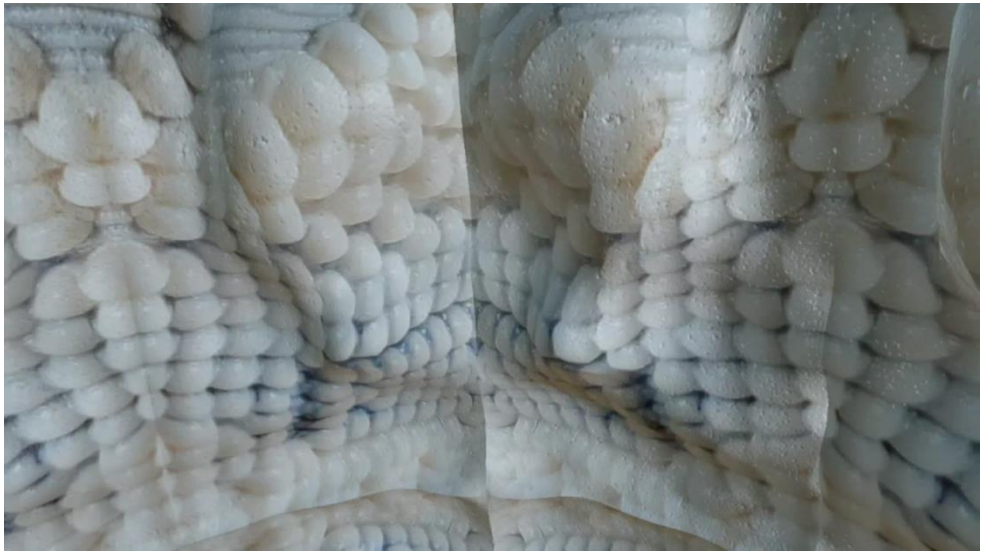
Sunday's Tablecloth
3D printed porcelain, pigments, glaze
18"x16"x15"

Gnostic (Ousia). 2023
Greg Kucera Gallery, Seattle

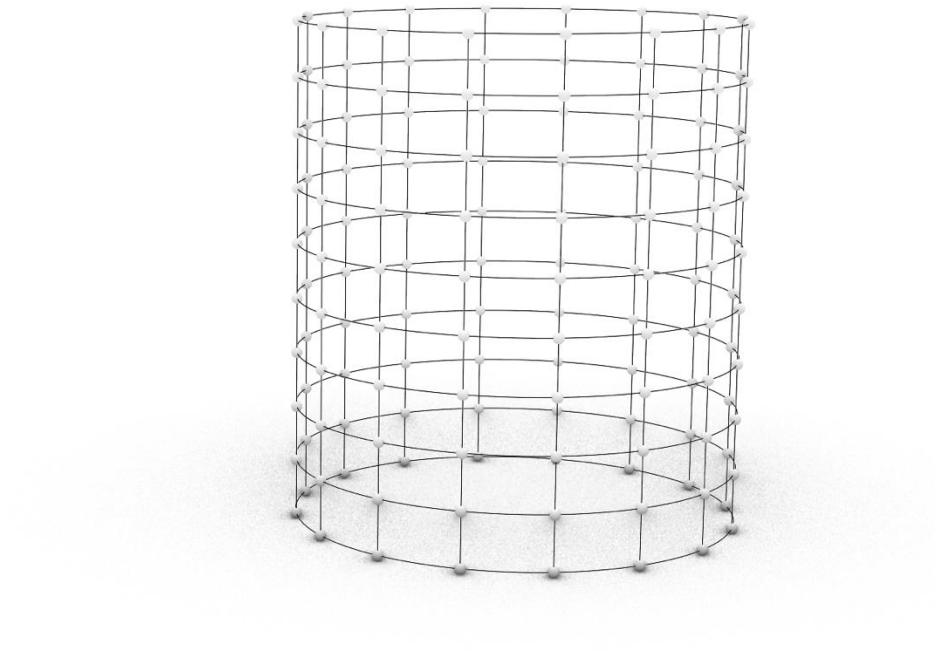
Tender. Probity. 2023
In the exhibition Tender. Greg Kucera Gallery, Seattle

Object Permanence.
2022
Installation with 3D printed porcelain, wood, custom wallpaper, single and dual channel videos, acrylic
Two-person exhibition with Sylvia Tur at the Bellevue Arts Museum

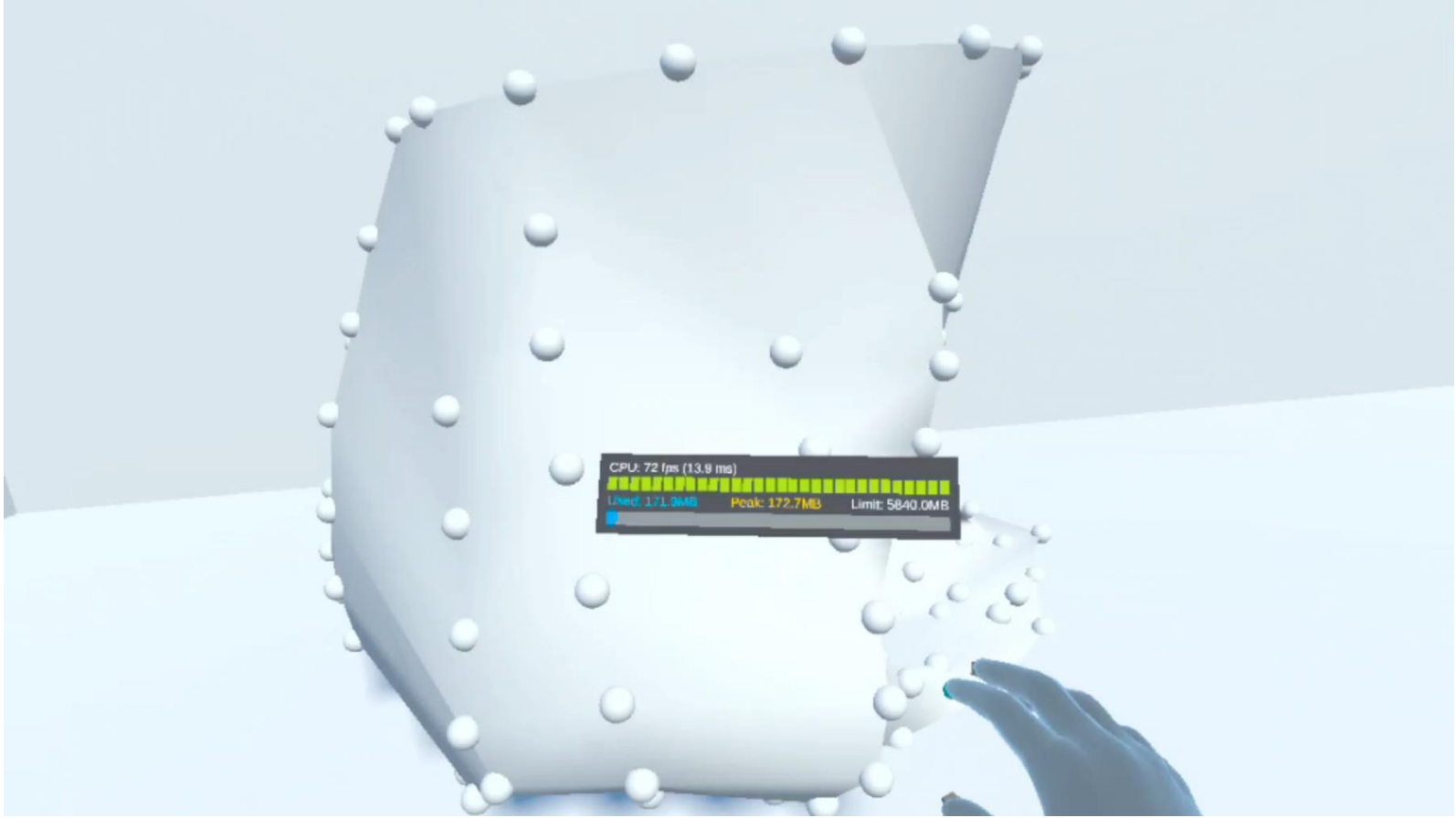
To Go Gentle. 2023
Installation with 3D printed porcelain, steel, acrylic, and video



Touching Space, Human-Responsive Virtual Reality
VR coding collaboration with Zoe Kaputa, CS, UW/Stanford.
Additional VR interaction research by Emi Yoshikawa, Joanie Foley, Madrona Kelly Maling, and John Akers.
Support by Kreisheimel-Jones Research Grant, University of Washington.

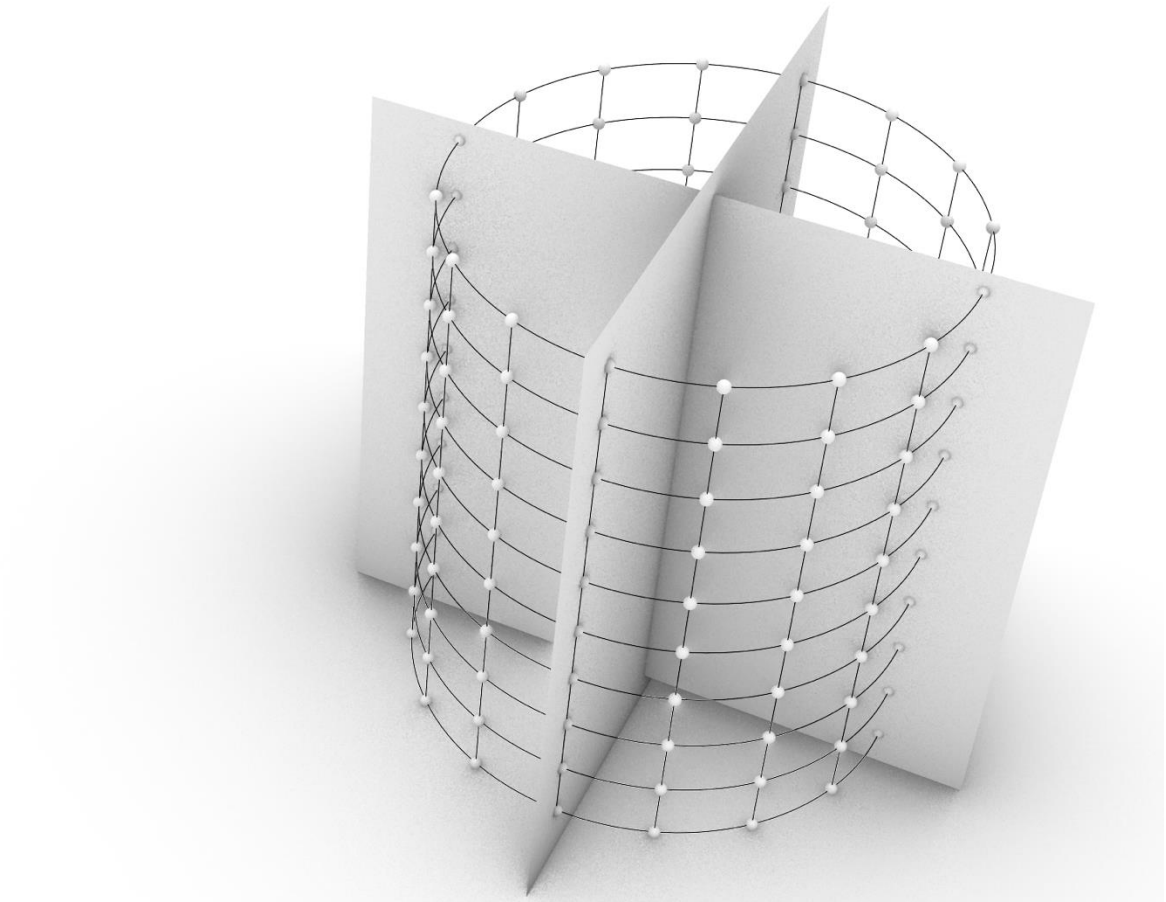


Springy wireframe model for Touching Space VR



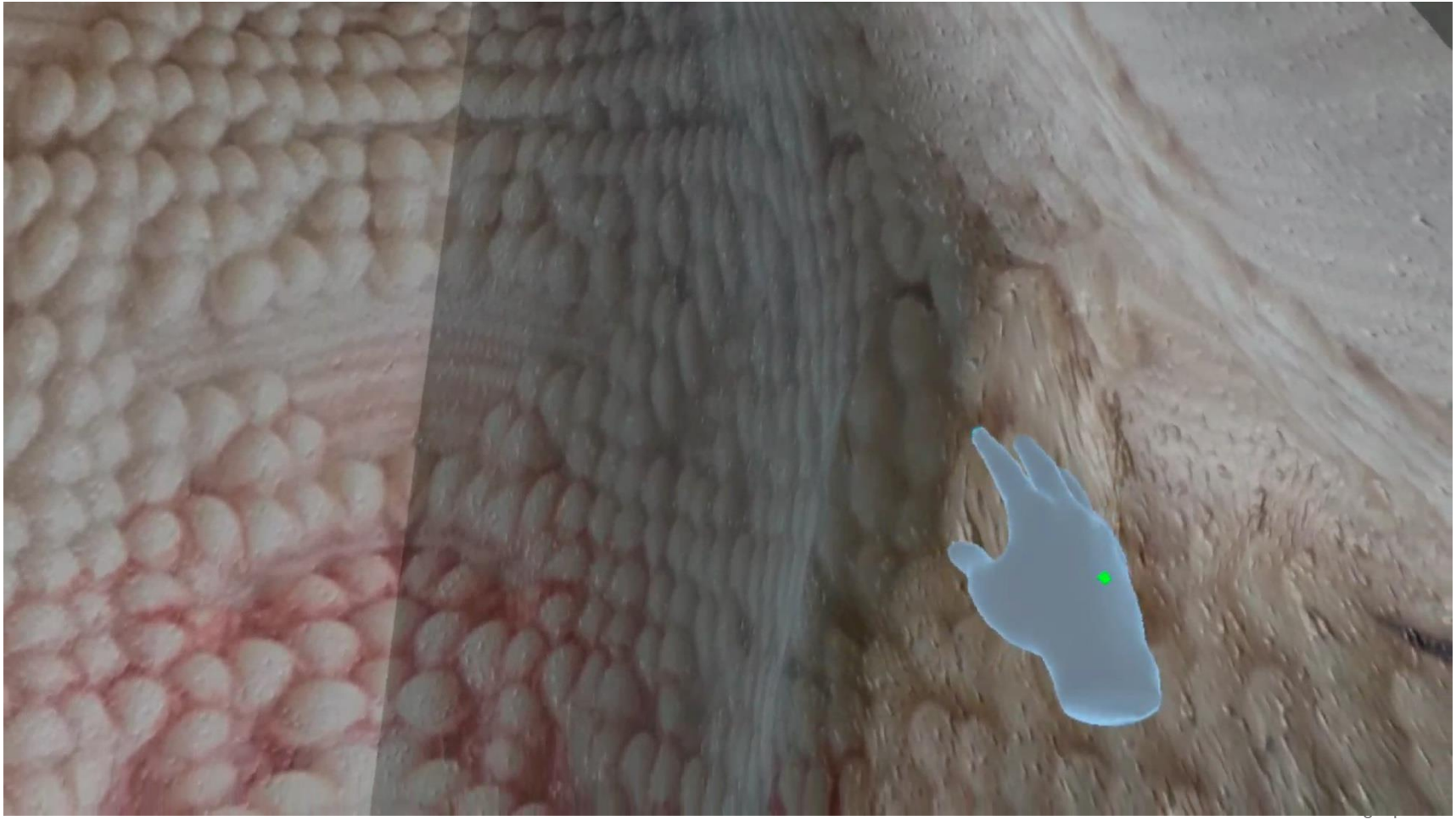
Preliminary research models for Touching Space VR

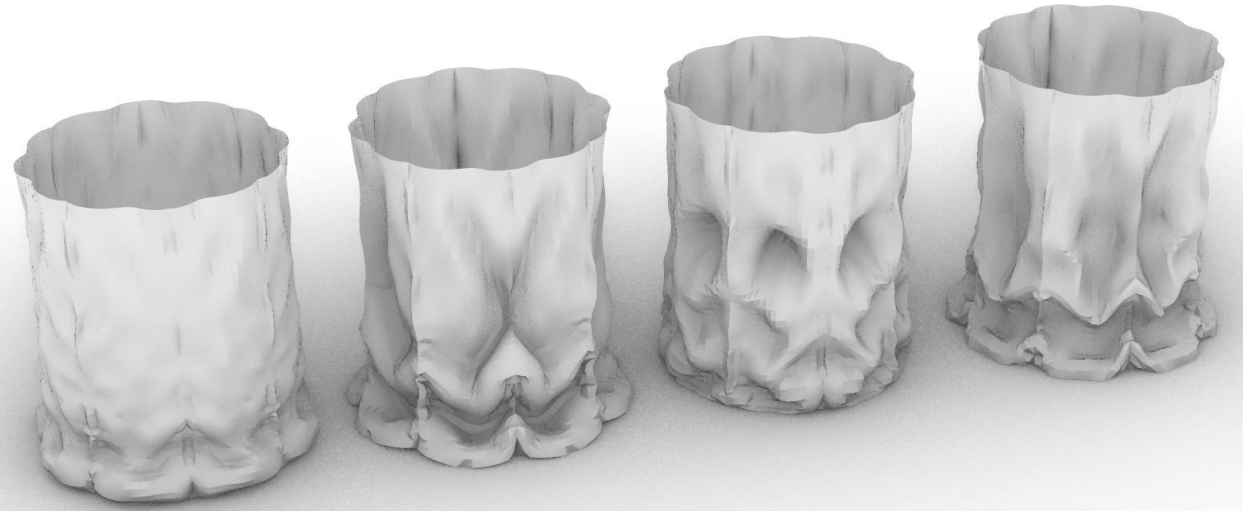
Preliminary research models for Touching Space
Human-Responsive Virtual Reality



Springy wireframe model with mirror planes for Touching Space VR

Touching Space
Human-Responsive Virtual Reality



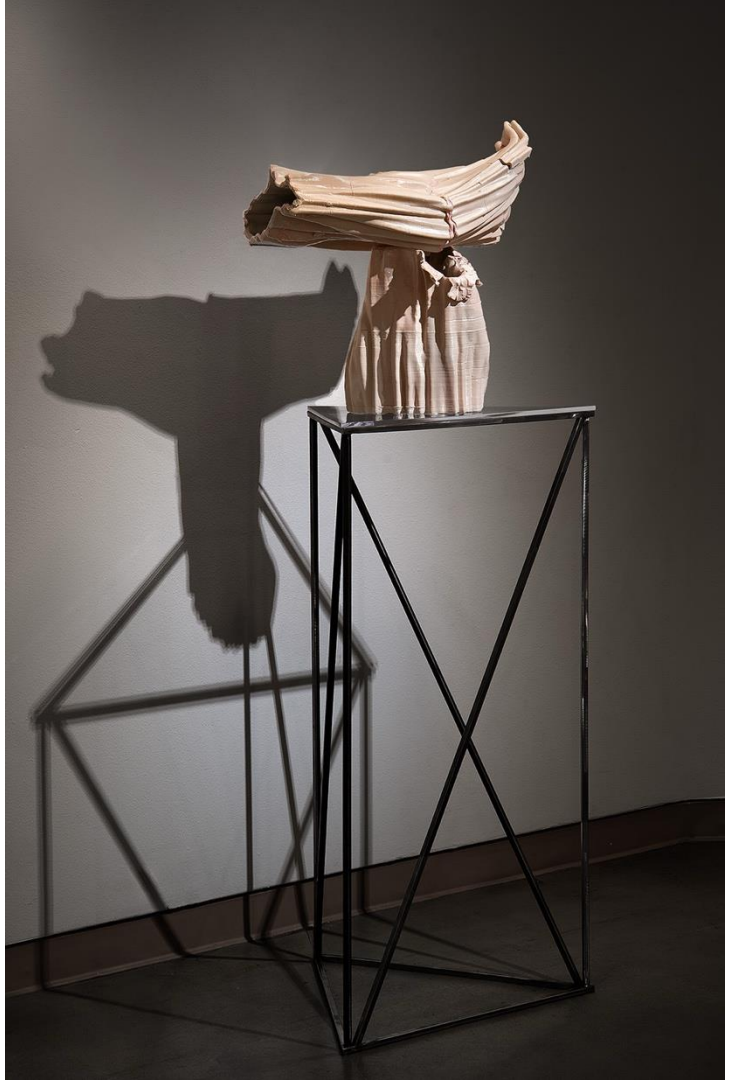


Form captures from Touching Space
Virtual Reality

Touching Space
Porcelain

Touching Space
Work in progress
Porcelain and pigmented porcelain





Winged Corpus at the Museum of Northwest Art

Touching Space
Work in progress at the Clay Studio of Santa Barbara

Pink Corpus
Porcelain, pigmented porcelain and glaze
32”x18”x18”

Corpus to Corpus 2025
Installation at the Museum of Northwest Art, La Conner, Washington

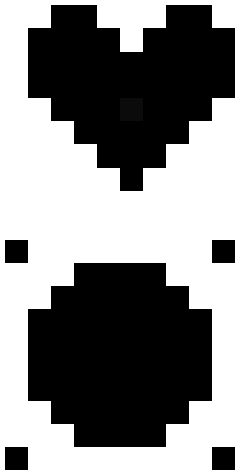
Where to, next?

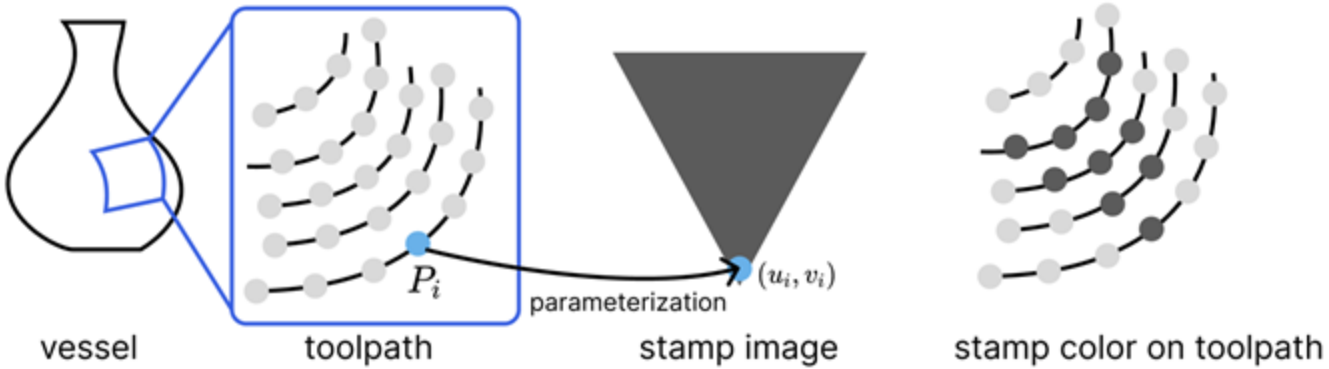
AR Clay Pottery tools (using Microsoft HoloLens)- Collaboration with Joyce Passananti, Computer Science, UCSB

AR Clay Pottery tools - Collaboration with Joyce Passananti, Computer Science, UCSB

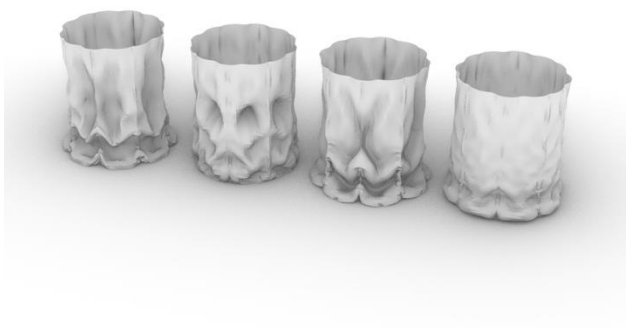
Example Stamps

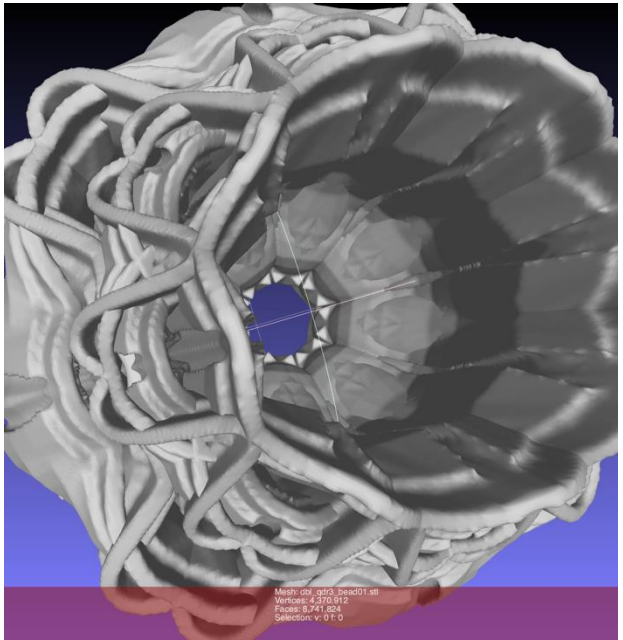
Stamp Application





Corpus Sonification
Collaboration with Bonnie Whiting
Upcoming Performance at the Museum of Northwest Art on April 19th





Stacked VR wireframes
(work in progress)

Thank you!

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