

Timea Tihanyi: Mathematics and 3D-Printing Ceramic Objects

Interview by [Martin Skrodzki](#) and [Milena Damrau](#) | Section: [Interviews](#)

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Abstract: In this conversation, Milena Damrau and Martin Skrodzki speak with Timea Tihanyi about the role of mathematics in her artistic practice. Timea Tihanyi is a Hungarian born interdisciplinary visual artist and ceramist living and working in Seattle, Washington.

Briefly describe your own work. Include a description on how your work relates to mathematics.

I am an interdisciplinary visual artist and ceramicist, working in the intersections of math, art, and design. I make ceramic objects in delicate porcelain using *extrusion-based 3D printing*, a digital process that layers thin coils of soft clay row by row, and builds complex textures by one tiny detail placed over the other. I work with the machine and with the properties of the ceramic material. My ideas revolve around the relationship between body and mind, the physical-tactile experience of the material and the abstract logic that governs the structures that can be made from it. This inquiry led me to be interested in mathematics: thinking about the iterative algorithmic nature of my digital tools and about the unexpected that might happen when technology meets one of the most ancient materials, clay.

Mathematics is central to every stage of the 3D printing process, from creating the initial digital design with Computer Aided Design (CAD) tools and preparing this form for the printer, which involves translating the geometry (surfaces and edges of the form) into numeric lines of machine code. Newer digital tools, which will continue to be increasingly used in 3D printing, such as parametric design, 3D scanning, and artificial intelligence (AI)/virtual reality (VR), would not exist without mathematics.

What drives/drove you to take an artistic approach to math or a mathematical approach to art?

I became interested in ways mathematics is able to create predictable models of changing natural systems, such as movements of landslides, animal populations, or viral spreads. I was asking questions about how math is used to predict changes and outcomes, and how forms of unpredictability: chaos, error, and glitch arise. While researching these questions, I came across amazing patterns made by mathematical equations and by generations of textile artisans (weavers, knitters, quilters, embroidery makers). They had both procedural and aesthetic resemblance, and I became interested in the bridges that could connect these distinct fields of practice. Each pattern is generated by iterating a set of simple rules, a process which creates complexity and, in some surprising occasions, unpredictability. I developed a process to make these algorithmically generated patterns three-dimensional and apply them onto ceramic forms, which then I further manipulate by hand. My mathematical process is collaborative. I often seek out the expertise of specific mathematicians and I also bring students into this research process.



Potterbot clay 3D printer in action at *Slip Rabbit Studio*. Photo: Timea Tihanyi.

Were you always drawn to math or did you discover it somewhat later in your life/career?

My background is in medicine and neuroscience, but outside of a general high school level public education, math was not part of it. I remember fondly of my math teacher from 5th-8th grades, who demanded us to think logically and strategically. I am married to a mathematician, whose magnetic explanations about manipulating objects in higher dimensions did not stop being fascinating despite our 30 years together. Our conversations have made me comfortable with what I started referring to as *mathematical thinking* - an ability available to and regularly used by everyone, everywhere in the world, to solve problems in logical and abstract ways. I'm interested in this dualism between hands-on making and abstraction. Learning-by-doing, which for me means testing raw ideas by the seat of my pants while observing very closely how materials and forms change as a result of my actions. In contrast, there are abstract ways of getting to these frontiers of knowledge: using indirect strategies, a form of mental gymnastics, in one's head. I think a balance of the two is absolutely necessary in most areas of life, and I enjoy exploring the limits of each knowledge finding method, as well as their possible intersections.

What (level of) mathematical knowledge did you have before you started to work on *MathArt* ? How much of the underlying mathematics did you need to learn in order to perform your work?

I do a lot of research on my own but I always reach out to experts in areas that I don't understand well. Mathematicians have been my most generous collaboration partners. I enjoy asking questions and problem solving together, and sharing with math people the tangible material forms that attempt to represent their formal thinking. I worked with Sara Billey (University of Washington) on several mathematical models, including the *Elementary Cellular Automaton*, a collection of cells that are either

alive or dead and change their status over several rounds depending on the status of their neighbours, and *Sandpile groups*, which represent how a very large pile of sand behaves when grains are falling of along pre-described neighborhood connections, with Frank Farris (Santa Clara University) on using the *Fourier series*, a method for reducing a complex signal into elementary parts, e.g., for MP3, for reproducing knitting stitches, and currently I co-teach a class with Jayadev Athreya (University of Washington) on *Embodied Math and Art*, which we had designed together.



Sandpile distribution patterns separated by value. Collaboration with Sara Billey and the WXML team (2019). Photo: Timea Tihanyi.

I believe that math is available to everyone; though our education systems often try to present it as a rarefied field, with its own secret language that is so removed from reality. In [our novel Art and Math course](#), we focus on skills of observation, movement and making that naturally use mathematical thinking and problem solving already, such as patterning in dance and weaving. We invite both indigenous and non-indigenous knowledge holders as guests to our course, and connect, in hands-on ways, what we learn from them with the students.

Did you learn new aspects about the underlying mathematics from the process of your work?

Each body of work that I have created using math has led me to a deeper understanding of not only the specific ideas involved but also of the nature of mathematical problem solving in general. Math is often one of the first steps in my process. It usually involves a code or algorithm that we set up, which will generate a pattern or a visual representation, which I then make into a 3D digital form first, then take to the 3D printer. As I mentioned before, there can be a really big gap between what can be made virtually/algorithmically on the computer and what can be made in real life with a soft and heavy plastic material, like wet clay. Small glitches often overcome the predictability of the algorithm, giving the

finished form unexpected and unique qualities. I really enjoy when these accidents happen and, as my next steps, I would like to find mathematical ways to produce them.

It also has happened that during our collaborative research, we were able to discover new math about sandpile groups, with regard to reducing redundant computations when the underlying graph has one or more symmetries (see Johnson, 2019), exactly because of challenges posed by the printing or the clay process. Each new mathematical idea I try gives me several more possible directions to explore. For example, I collaborated with designer Audrey Desjardins (University of Washington) to make sound data tactile in the form of little bumps on the printed clay surface. Later, in my *Pathfinder* series, I implemented trigonometry into a simple algorithm that moves the printer's extrusion nozzle on an alternative path every time the sound reaches a certain intensity. These detours of the printing nozzle created subtle undulations of the wall locally, which eventually affected the entirety of the piece. As an outcome, in *Inner Ear*, our most recent collaboration with Audrey, we are putting the sensor data through an algorithm which simulates differential growth, transforming the walls into ruffled coral-like surfaces. I really thrive on this kind of flow from one idea to the other, using one project to inspire the other.



Timea Tihanyi: *Pathfinder* (2018). Image: artist's own.

What do you think observers of your artwork learn or gain regarding the underlying mathematics or arts? How explicit is the mathematics in your work?

In some of my pieces, like the *Burst and Follow* and the *Matrix* series, math is more explicit. I really enjoy talking about the connection between art and math, but honestly, the work has to be personal and go beyond the representation of mathematics to become meaningful to me. I think art making is a way of telling our stories, sharing those with one another in hopes of striking a cord, finding connections. Of

course, making mathematics is also a way of revealing ourselves to the world and, in turn, revealing the world to us. In my work, the story of my experience, the story of the brain making itself, the story of math, and the story of the material are inseparable from one another.

The feedback I get from audiences at my shows seems to confirm this. We appreciate math more when it is embedded in our field experience, when it surprises us, when it solves things that could not be solved in the tangible world of hands-on experience. But we love it exactly because it is embedded in this experience of being a human mind in a human body. Peoples, for thousands of years, have connected with one another through stories and shared experiences. And math is part of these.

What new insights did other people, possibly even mathematicians, gain from your work?

I think I would leave this to the mathematicians to answer. The fact that I meet mathematicians who are interested in talking to me about my work and collaborating with me, makes me hope that my work can provide them with something that was not yet readily available in their own areas. Some people are drawn to aesthetic aspects, some are to the secrets of the process, and some to the underlying ideas. We human beings are both visual and embodied creatures, and these are exactly where math has a tendency to fall short. So, math and art makes a good marriage, right?

Is there anything else you want to mention about yourself, your work, or anything else related to *MathArt*?

I am completely self-taught in 3D printing, coding, and digital technologies. It's quite impossible to master every current and new tool and no maker needs to. In the past five years, these processes have rapidly been becoming consumer friendly and accessible. With 3D scanners, AI aided image making, and soon AI 3D making, tools of technology have been becoming ubiquitous and unavoidable. However, there is still a great gap between those with economic and academic privilege, and those who have to overcome greater barriers in their access to these technologies. We makers, academics, and technologists have to be mindful of these very real obstacles of knowledge acquisition and dismantle the barriers actively and steadily. In 2017, I founded a studio, *Slip Rabbit*, which I still direct, for the advancement of 3D printing in ceramics. We use experimental, interdisciplinary means to explore how each step of the printing process can be expanded and connected together more seamlessly using both advanced and elementary methods. *Slip Rabbit* hosts residencies, internships and collaborations, and has published a book on 3D printing and math, which is available as a free download from our website <https://www.sliprabbit.org/>.

Where can people find more about you and your work?

My art website <https://www.timeatihanyi.com/> has photos of the projects and more information about these. There are also more details about my process and math collaborations in my book, *Making and Breaking Rules: Algorithmic Forms and Tactile Processes – A Technoceramist's Adventures with Mathematical Thinking*.

References

Johnson, E. (2019). *Sandpile Group on a Hexagonal Grid*. Master thesis, University of Washington. <http://hdl.handle.net/1773/44375>

Details of the cover photo: Timea Tihanyi: *Burst and Follow* series (2018). Photo: Timea Tihanyi.

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