

## Creations

# Infinitely Variable Tiling Patterns: From Truchet to Sol LeWitt Revisited

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Repeating patterns in architecture are utilized in elements at a variety of scales, from a façade to perforated ceilings and wall reliefs to carpeting and tile stonework. The Truchet tiling concept is one means to develop a modular non-repeating pattern. This paper explores some of the basic concepts of Truchet tilings, variations developed, and some current examples of using these methods with digital generation and fabrication methods.

## Background

A number of formal repeating pattern concepts and systems exist for designers and architects to utilize. They may as simple as uniform tilings, patterns, and frieze and wallpaper groups or as complex as systems that can use randomness for placing individual patterns. Grunbaum and Shephard offer a comprehensive and systematic treatment of the subject.<sup>1</sup> With the greater introduction of digitally based generative systems and algorithmically generated patterns and a greater means of digitally controlled fabrication, the concept of many-of-one (for example: many instances of the same tile pattern) is becoming one-of-many. As real-time steaming fabrication evolves, the need for non-repeating patterns will be easier to satisfy.

One such patterning concept that can be revisited is the modular shape combinations first observed and developed by Father Sebastien Truchet. Father Truchet (1657–1729) was of the French clergyman living in Lyon. He is known for being active in areas of mathematics, hydraulics, graphics, and typography. [Figure 1A](#) displays one of the many periodic patterns he developed. In 1704, he published “Memoir sur les combinaisons,” in which a number of plates were developed to show periodic patterns.<sup>2</sup>

A basic concept that one can see of Truchet tiling is that adjacent tiles can create much larger contiguous edge connecting patterns. In 1987, Cyril Smith analyzed the structure of Truchet’s tiling and first abstracted them into simple diagonal lines and then into two arcs starting and ending at edge midpoints ([Figure 1B](#)).<sup>4</sup> Smith wrote about the closures that were being formed—circles—and also showed a color-filled example to further highlight these positive and negative, concave and convex patterns<sup>1</sup> ([Figure 1C](#)).

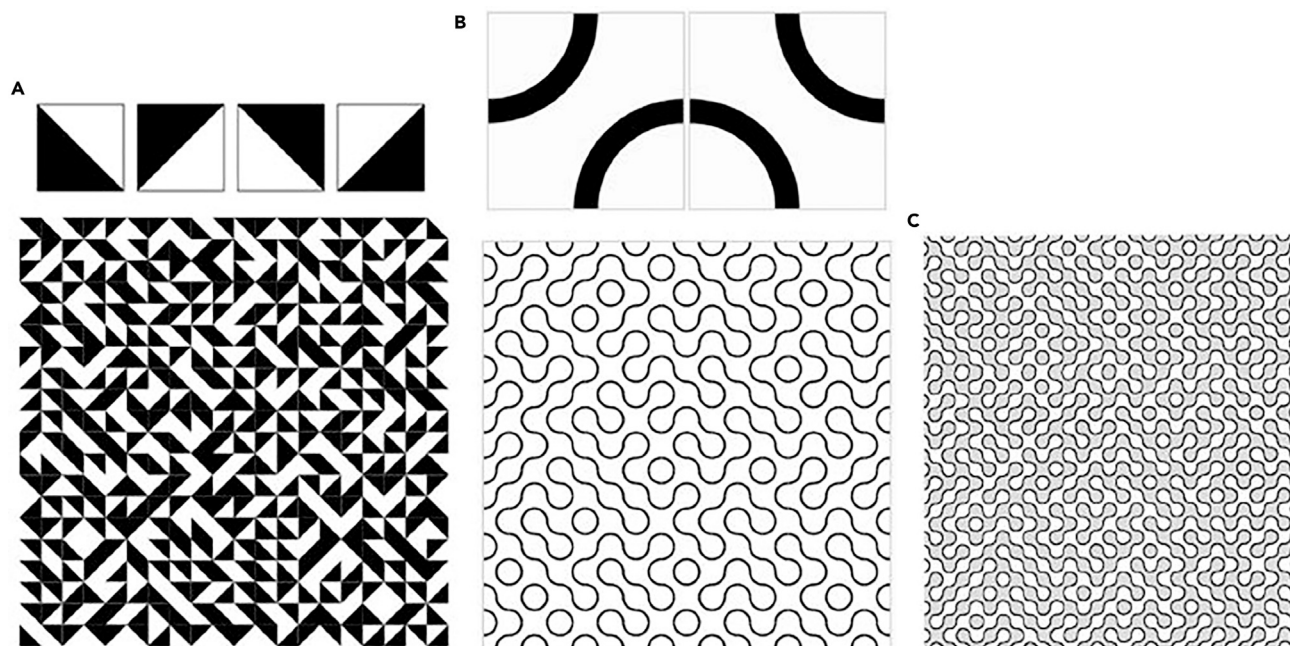
## Developing Truchet-like Tiling

The initial interpretation of the underlying concept of Truchet tiling was the connection of the midpoints of adjacent edges. Others have since developed tiles using two and three equal subdivisions of edges and edge points connected with arcs, straight line segments, or ribbons. In 2005, I developed a total of three tiles with symmetry across the diagonal. The ribbon connector was used to develop a coloring density between the foreground and background. The initial tiles were fabricated with a laser cutter using two tones of wood—in this case, inexpensive 1/8” MDF (medium-density fiberboard). The bottom layer was an 11-inch square of light-toned MDF, and the top layer consisted of a series of 1.25-inch ribbons of a darker-toned MDF. The plan for these wooden tiles was to attach them to a wall surface in a manner in which they could be reoriented individually on a regular basis. The full fabrication of this vision was never realized.

These initial tiles were also replicated in a 20-inch square array, randomly rotating each tile as it was placed. A black-and-white version and a color series of these images were also developed and titled “Paths,” which can be found at [BitArtWorks.com](http://BitArtWorks.com). The Paths series explores using a single tile or randomly selecting one from two or more different tiles. Using multiple tiles in a single tiling offered a greater opportunity for variation.

For an installation at the 2010 Art Loop Open, I displayed an interactive modular tiling piece. I developed a version of the tiles as a set of 4-inch square magnets, and these were placed a set of steel sheets in a





**Figure 1. Evolution of Tilings**

(A) Truchet pattern, (B) Smith variation, and (C) Smith shading.

six by 3-foot frame. Viewers were encouraged to pick up any one of a total of 128 magnets, rotate it, and place it back on the steel sheet surface. [Figure 2](#) displays a single magnet, some initial arrangements, and shows the complete installed piece onsite.

The wall piece led to an interest in developing a larger, more variable piece that could be interactive but also more three dimensional (3D). I developed a series of tile designs that could be placed on the surfaces of a cube. The solid ribbons that were in the print and magnet tiles were recreated as three much thinner ribbons. The intersection of the multiple-banded ribbons forms a very interesting blending and, when laser cut and assembled into a cube, give the cube a very light and lacy appearance ([Figure 2B](#)).

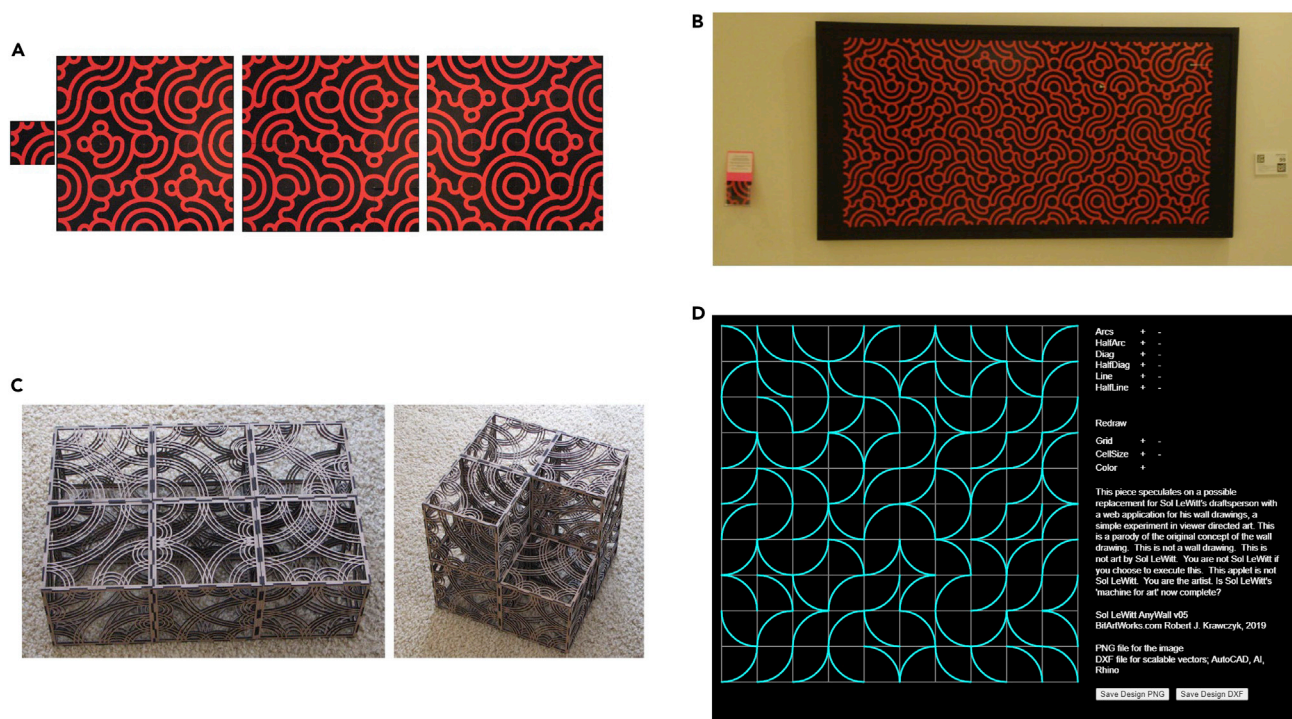
The Paths series also mimics the concept Sol LeWitt developed in his wall drawings, particularly his piece from 1981, #358.<sup>3</sup> The wall drawings consisted of drawn arcs or lines connecting opposite corners of a grid where his crew was instructed to determine the orientation of the arc or line as they executed each individual module. In this case, the software replaces the crew and an algorithm using a random function computes the rotation of the module, replacing the decision of the individual crew person. Each time a tiling pattern is pattern executed, a unique piece is generated. An online example of this process, in app form, can be found at [BitArtWorks.com](http://BitArtWorks.com) ([Figure 2C](#)).

### Path of Your Own Series

The Paths Series has a strong personal context.

My own exploration in art consists of a series of paths taken and not taken, each part of the great whole that is sometimes not well understood. These pieces allow me to investigate what in life is at times difficult: what happens if you change your direction or decisions made on opportunities that are presented to you. In art, I can visualize changes without real repercussions, shown in ([Figure 3](#)). The pieces also form some very interesting labyrinths that show how complex and rich life is; they show me that transitions from one point to another are truly the hidden meaning and joy in life.

The tiles or cubes give the viewer the same chance to pick an opportunity on their own. They can contemplate that in life many choices need to be made; some simple changes do not disrupt the whole much, but some do, and of course at some point your opportunities do end. It also lets the viewer see the whole as well as see where one paths leads to another, which is very difficult in actual life. The 3D cubes offer another dimension to the paths; more complex than the tiles or the prints, which freeze one set of



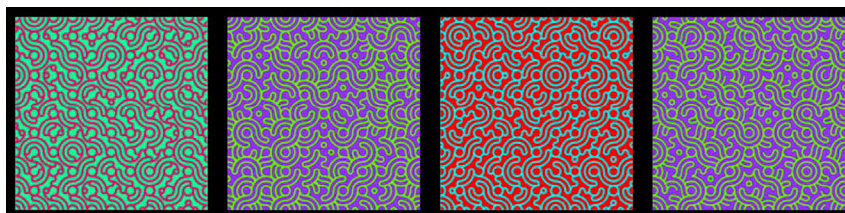
**Figure 2. Variety of Expressions**

- (A) Printed magnet tiles, red ribbons on black background.  
 (B) Installation at 2010 Art Loop Open in Chicago.  
 (C) Laser-cut cubes.  
 (D) Example output from the Sol LeWitt AnyWall App, [BitArtWorks.com](http://BitArtWorks.com).

decisions, the transparency allows them to see other paths not taken and what could happen—also not possible in actual life. These pieces were meant to be interactive and contemplative but mostly fun—the engaging kind of fun that frees you to think about more important issues.

## Conclusions

These studies began as an attempt to demonstrate some of the possibilities of using a modular design element with random selection and random orientation to generate repeating patterns that would most likely not actually repeat. They turned into an exploration the paths taken and not taken, providing an overview of the outcomes of choices that are not possible to see in one's own life. These tiling techniques allow for the creation of pieces where each piece manufactured could be a unique combination of basic elements. In some emerging technologies, such as large-scale carpet printers, if the design were to be streamed horizontal row by row, a very large area could be manufactured without any repetition. Otherwise, less technical-demanding tiling systems such as carpet, wall, and ceiling tiles and panels could be economically manufactured while still offering a very great variety of unique installations.



**Figure 3. Path of Your Own**

These patterns, although algorithmically simple to generate, provide a seemingly complex image that allows one to contemplate how perception can change according to whether one is viewing the paths from above, as a whole, or while tracing them individually.

#### ACKNOWLEDGMENTS

This paper is based on one presented at the ISAMA, Conference of The International Society the Arts, Mathematics and Architecture, Chicago, IL, June 2011, titled “Truchet Tilings Revisited.” An expanded version that includes more recent 2D and 3D variations and prints is at: [bitartworks.com/paths01/gallery01.html](http://bitartworks.com/paths01/gallery01.html).

#### REFERENCES

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#### About the Authors

**Robert Krawczyk** is a native of the Chicago area, now living nearby in Batavia. Most recently, he was a Professor at the College of Architecture at the Illinois Institute of Technology in Chicago, focusing on digital craftsmanship. During his 35 years at IIT, he developed and taught a series of computer-aided design and digital design courses. His research into digital methods in the disciplines of science, mathematics, architecture, art, and technology has been published and presented internationally in the form of papers, prints, web pieces, sculptural, and architectural studies—developing custom algorithmic software utilizing laser cutters and 3D printers. He has been an exhibiting digital artist since 1997. His artwork can be found at [www.BitArtWorks.com](http://www.BitArtWorks.com), and student work, papers, and other projects are at <https://www.iit.edu/~krawczyk>.