Infinitely Variable Tiling Patterns: From Truchet to Sol LeWitt Revisited

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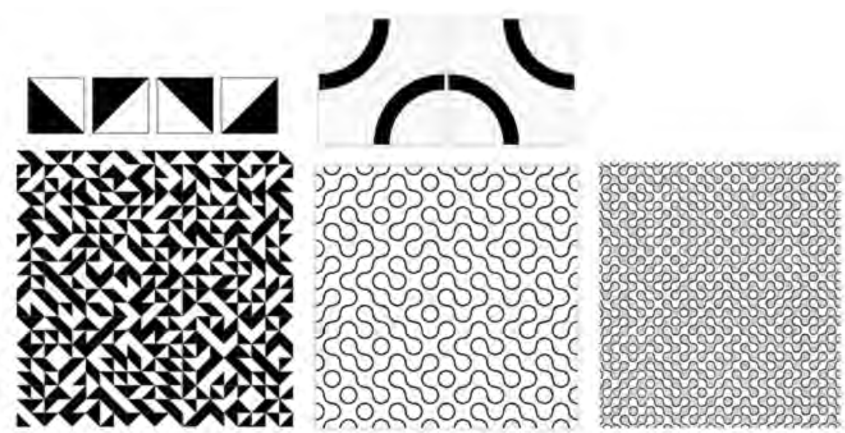
Abstract

Repeating patterns in architecture are utilized in elements at a variety of scales; scale of a facade, perforated ceilings, and wall reliefs to carpeting and tile stonework. The Truchet tiling concept can now be reconsidered as one means to develop a modular non-repeating pattern. This paper explores some of the basic concepts of Truchet tilings and 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 system exist for designers and architects to utilize. They may as simple as uniform tilings and patterns, frieze and wallpaper groups, or complex as systems that can use randomness for placing individual patterns. Grunnbaum and Shephard offer a comprehensive and systematic treatment of the subject [1]. With the greater introduction of digitally based generative systems, algorithmically generated patterns, and greater means of digitally controlled fabrication, the concept of many-of-one is becoming one-of-many. As real-time steaming fabrication evolves, the need for non-repeating patterns will be easier to satisfy.



a. *b.* *c.*

Figure 1: *Truchet pattern, Smith variation, Smith shading.*

One such patterning concept which 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. An excellent repository of links to Truchet's writings and plates can be found on Jacques Andre's website

[2]. 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. In 1722, P. Dominique Douat further elaborates on Truchet tiling [4]. Lord & S Ranganathan cover both Truchet and Douat’s patterns [5]. The Andre website also includes the writings of Douat [2].

One of the basic concepts 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 [6]. Smith wrote about the closures that were being formed, circles; and also showed an example that was color filled to further highlight these positive and negative, concave and convex patterns, Figure 1c.

In 1977, Martin Gardner wrote about non-periodic tiling on dart and kites that included arcs connecting midpoint edges [7]. Later, 1989 and 1990 Clifford Pickover also wrote about arc tiles used the generation of random tiling patterns [7][8]. C. Browne further investigated the shading of the Truchet tiling by including examples using triangular and hexagonal tiles [10][11].

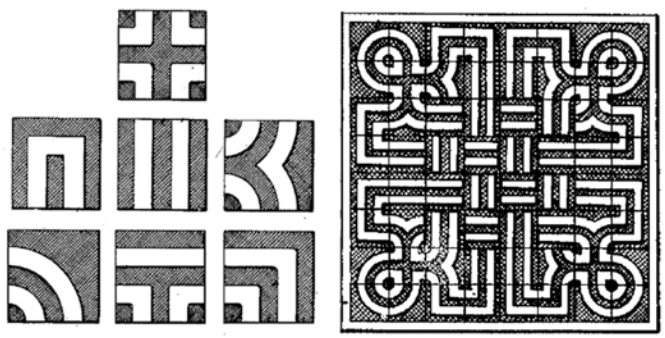


Figure 2: *Toy Designing Blocks by Graham, 1934.*

Following non-academic research and writing, we find that in 1934, a patent for a Toy Designing Block was granted to Tom C. Graham, 1,973,564, Figure 2 [12] This patent expired and 1991 patent 5,011,411 was granted to a Method of Making a Non-Repetitive Modular Design to Andreas F. Loewy [13]. It expired in 2003 for nonpayment of maintenance fees. Researching previous art of these patents also uncovered US Patent 1,453,728 Means for Devising Ornamental Designs granted in 1923 to F. J. Rhodes [14]. It has at least of the modular patterns that appear later, the two arcs at the midpoints.

As demonstrated by Loewy, the concept of how the adjoining edges could extend to a larger design was well understood, as seen here in his description:

“Each module is made in the following manner. Assume that the regular polygon has n sides. First, one chooses a set of points on one of the sides of the polygon, the points being distributed symmetrically around the midpoint of the side. Then, one duplicates this arrangement of points on each of the remaining sides. Next, one connects pairs of points with lines, such that every point is connected to one line. The lines can be straight or curved, but they must be continuous. The lines are drawn such that the resulting pattern is not symmetrical around any imaginary straight line joining any pair of vertices of the polygon. Finally, one can optionally fill in some or all of the spaces defined by pairs of lines, or by one or more lines and one or more sides of the polygon, with color or with some other design element.” [13]

More recently, US Patent 3,464,145 Set of Blocks for Generating Designs was granted to P. C. Martin in 1969 [15] and US Patent application 10/792,627, System of Combinable Patterns that Generates Artful Designs submitted in 2004 by Pablo Fernando Cha included many of the same concepts as others before him [16]. This application was abandoned in 2008.

It should be noted that none of the patent descriptions ever mentioned the work of Truchet, Smith, or any others noted here; and also, none of the writings of Smith and others ever mention the work being applied and granted for patents.

The Truchet tiling have also appeared in three-dimensions as in Browne [10]. Bowne also includes a diagram that has the tiling on the face of a cube; it is a diagram for the resulting surface model. Browne also extends these three-dimensional models with the use of spheres.

Developing Truchet-like Tiling

The initial interpretation of the underlying concept of Truchet tiling was the connection of the midpoints of adjacent edges. We have seen in the patent search that others have also developed tiles using two and three equal subdivisions of edges. We have also seen the edge points connected with arcs and with straight line segments or ribbons. To further explore this tiling concept, a number of versions were developed in 2005, with two and three edges points were developed. From that series a total of three tiles emerged. Figure 9 displays the first set of tiles developed. It these tiles symmetry is 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. Referring to Figure 10, the backing, the bottom layer, was simply a 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 that they could be reoriented individually on a regular basis. The full fabrication of this version was never realized.

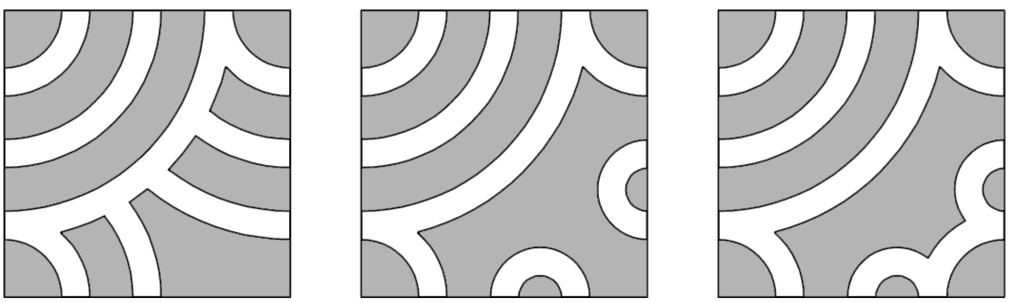


Figure 9: *Initial tile patterns developed.*

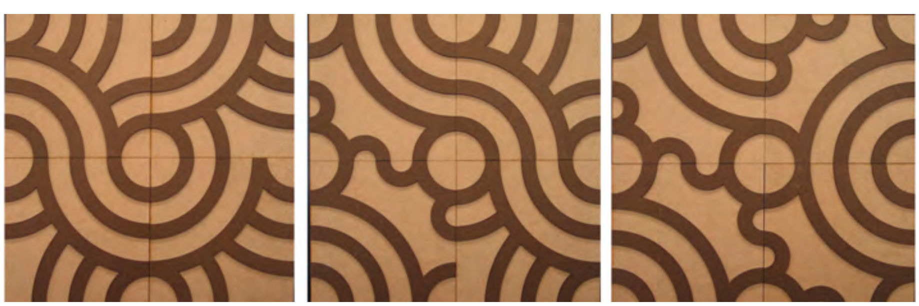


Figure 10: *Laser cut tiles, using two tones of wood.*

Theses initial tiles were also replicated in a 20-inch square array, randomly rotating each tile as it was placed. Figure 11 displays a black and white version of these images, a color series of these were also developed and titled Paths [17]. The Path 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.

Figure 11: *Image printed version of the random tiling.*

The Path Series also mimics the concept Sol LeWitt developed in his Wall Drawings, in particularly #358, 1981, which consists of arcs drawn from opposite corners of a square grid pattern [18]. 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.

For an installation at the 2010 Art Loop Open, an interactive modular tiling piece was proposed and selected. A version of the tiles was developed as a four-inch square magnet. A set of steel sheets were placed in a six by three-foot frame. A total of 128 magnets were placed on the surface and viewers were encouraged to pick up any one of them, rotate it, and place it back. Figure 12 displays a single magnet and some initial arrangements, and Figure 13 shows the complete installed piece onsite.

Figure 12: *Printed magnet tiles, red ribbons on black background.*

Figure 13: *Installation at 2010 Art Loop Open in Chicago.*

Research has also found similar tile designs, both as a square tile and a triangular tile configuration by Japanese architect and designer Asao Tokolo [19]. His website does not cover the design development of these tiles nor how they originated. His designs consist of five edge points and are more free-form in the ribbon shapes included.

Developing Three-Dimensional Tiling

The wall piece let to an interest to developing a larger, more variable piece that could also be interactive but possibly more three-dimensional. This let to developing 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.

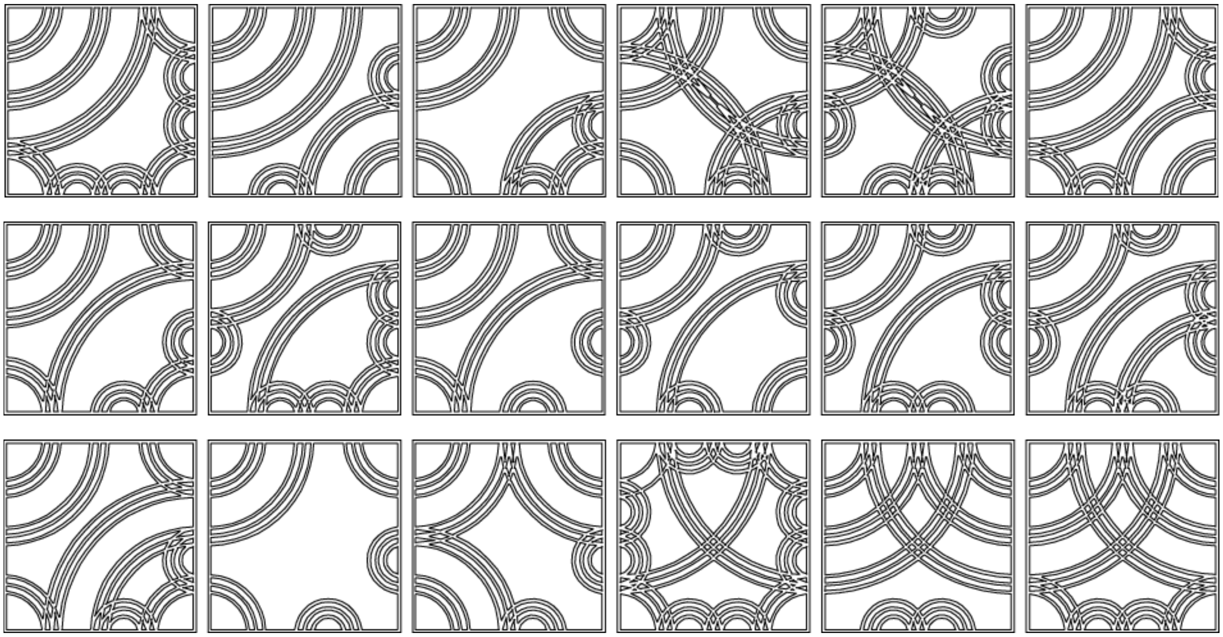


Figure 15: *Tile designs for cube surfaces, diagonal symmetry.*

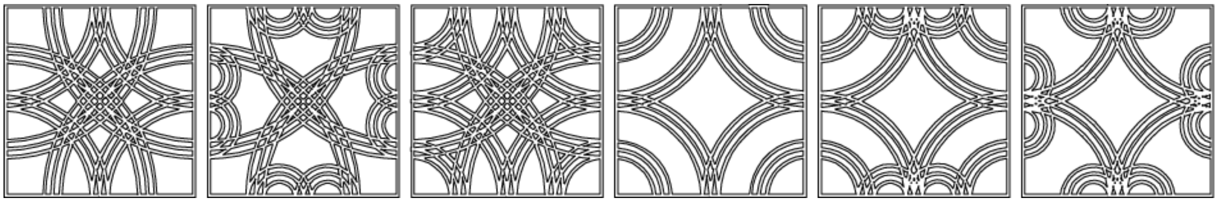


Figure 16: *Tile designs for cube surfaces, horizontal and vertical symmetry.*

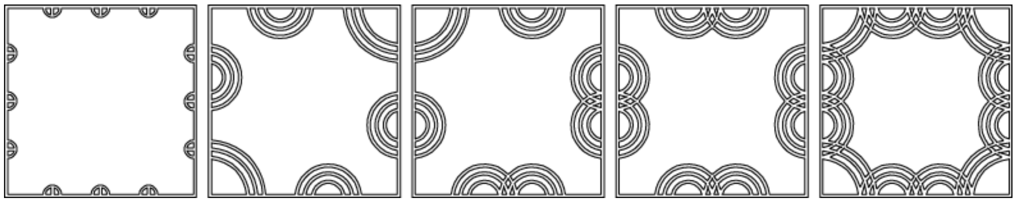


Figure 17: *Tile designs for cube surfaces, terminators.*

Figures 15, 16, and 17 display some of the designs that were developed. All display some symmetry and all consist of simple arcs connecting any the three edge points. The last set includes a series of terminators for the ribbons. These will in a future study be filled in with color and generated as prints using a random selection individual modules and random orientation.

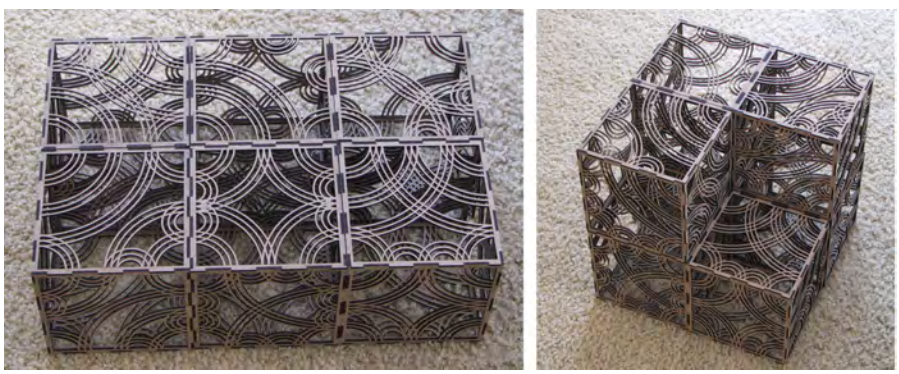


Figure 18: *Laser cut cubes.*

Figure 18 displays the final assembled laser cut six-inch cubes. An overlapping edge was developed so the cubes could be easily assembled. The most similar item currently on the market is a block game titled Motif Cubes Wooden Block Game, designed by newartifacts, a group of artists and designers from Uruguay, South America. These consist of nine 1 3/8 inch painted cubes. Browne also has developed a series of games that are based on Truchet-like tiling of all different shapes, three-dimensional and two-dimensional [20].

Path of Your Own Series

The Paths Series does have a strong personal context.

My own exploration in art consists of a series of paths taken and not taken, each part of 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 the entirely of such changes without real serious repercussions, shown in Figures 19 and 20. The pieces also form some very interesting labyrinths which show how complex and rich life really is. They also show me that the path of the path, transitions from one point to another, are truly the hidden meaning and joy in life. It's not the destination as much as the times spend on the path itself, said by many.

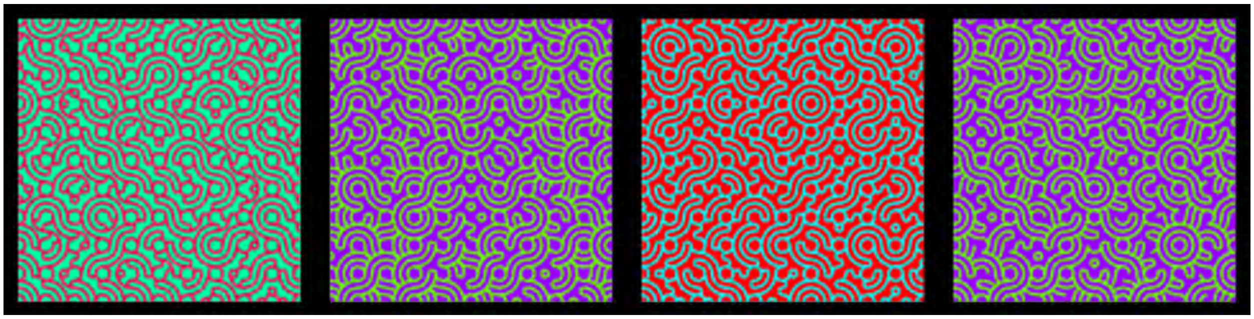


Figure 19: *Path of Your Own prints.*

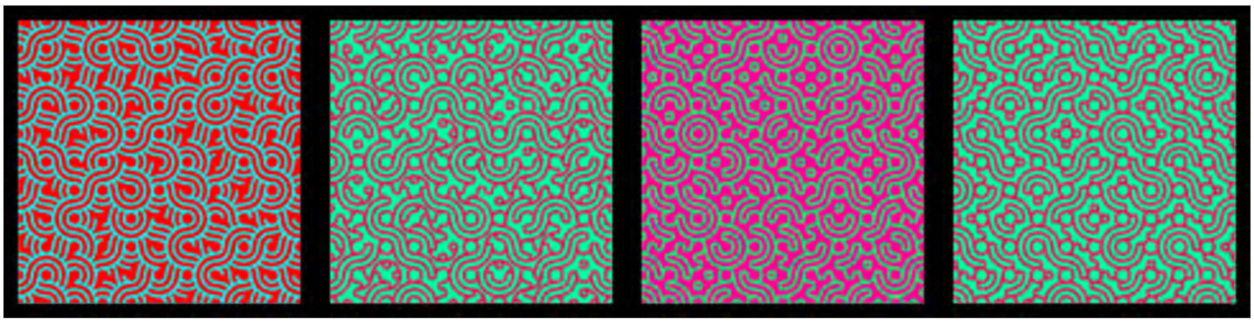


Figure 20: *Path of Your Own prints.*

The tiles or 3D version of 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 and see where one paths leads to another; 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 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.

Summary

These studies begin 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. With the utilization of a digitally driven fabrication system, 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.

Acknowledgements

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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 craftmanship. During his thirty-five 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 prints, web pieces, sculptural, and architectural studies; developing custom algorithmic software with laser cutters and 3D printers. He has been an exhibiting digital artist since 1997. His artwork can be found at: www.BitArtWorks.com and student work, papers, and other projects are at: www.iit.edu/~krawczyk