10 PRINT CHR$(205.5+RND(1)); : GOTO 10

NICK MONTFORT, PATSY BAUDOIN,
JOHN BELL, IAN BOGOST, JEREMY DOUGLASS,
MARK C. MARINO, MICHAEL MATEAS,
CASEY REAS, MARK SAMPLE, NOAH VAWTER

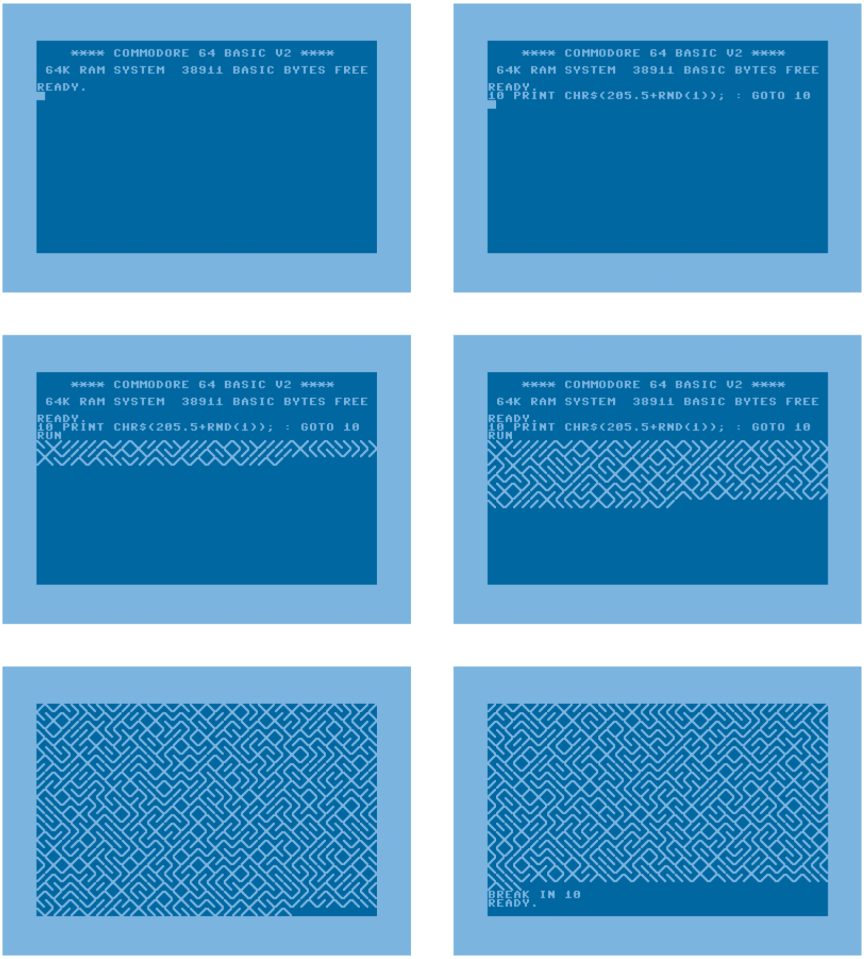

Figure 10.1

From left to right and top to bottom, the `10 PRINT` program is typed into the Commodore 64 and is run. Output scrolls across the screen until it is stopped.

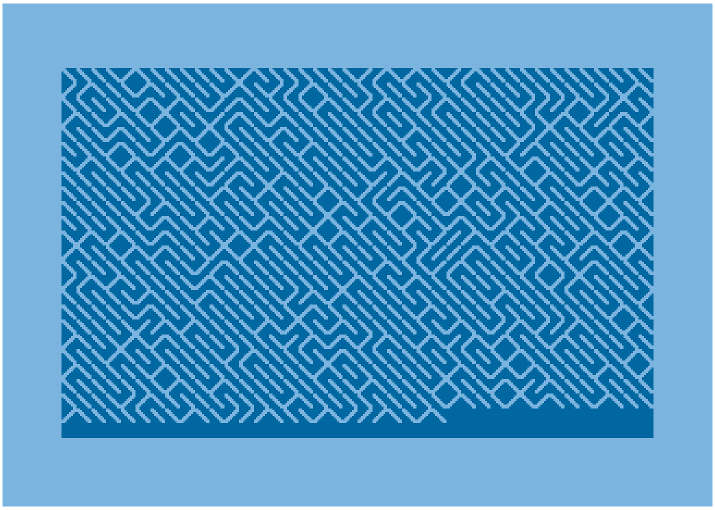

Figure 15.1

```
10 PRINT CHR$(205.25+RND(1)); : GOTO 10
```

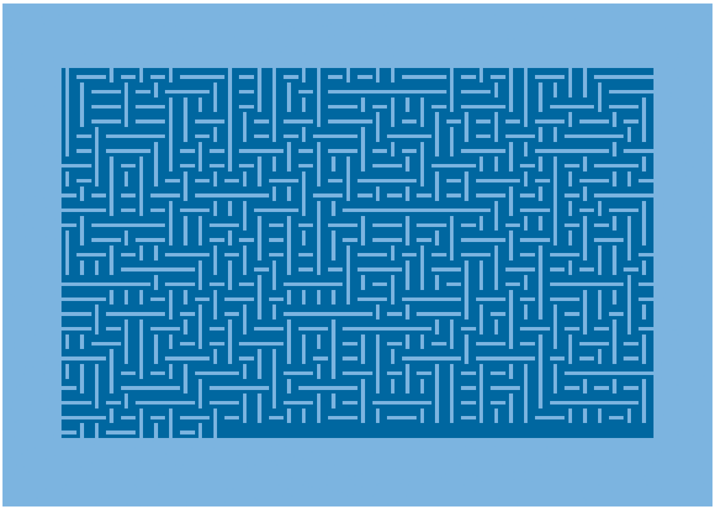

Figure 15.2

```
10 PRINT CHR$(198.5+RND(1)); : GOTO 10
```

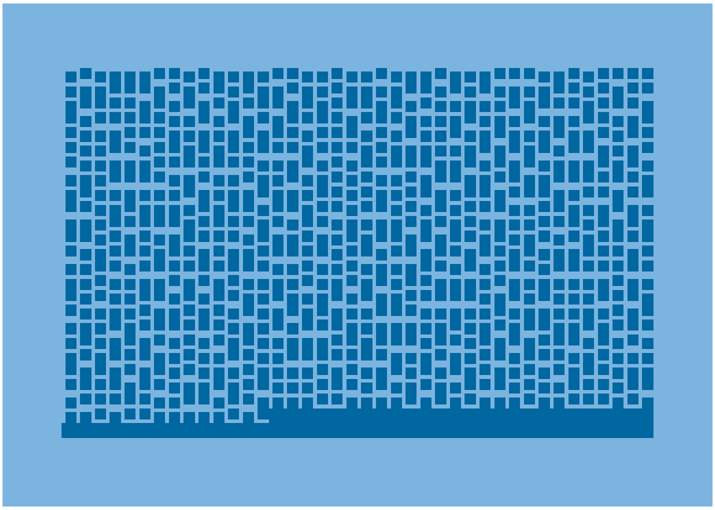

Figure 15.3

```
10 PRINT CHR$(204+(INT(RND(1)+.5)*3)); : GOTO 10
```

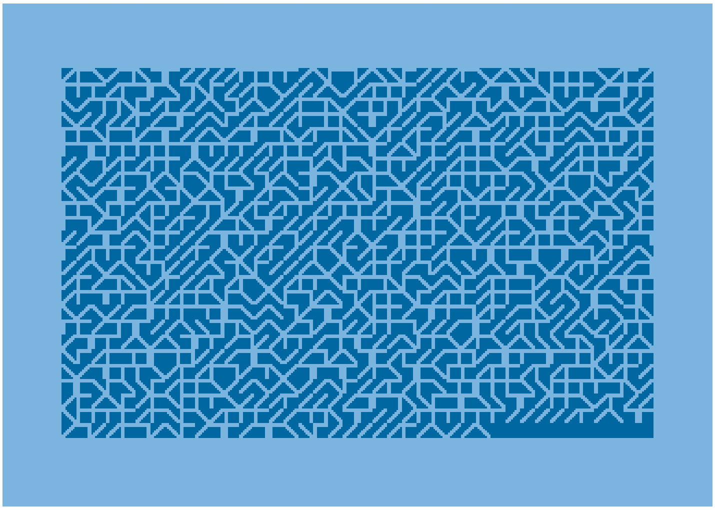

Figure 15.4

```
10 PRINT CHR$(204+(RND(1)+.5)*3); : GOTO 10
```

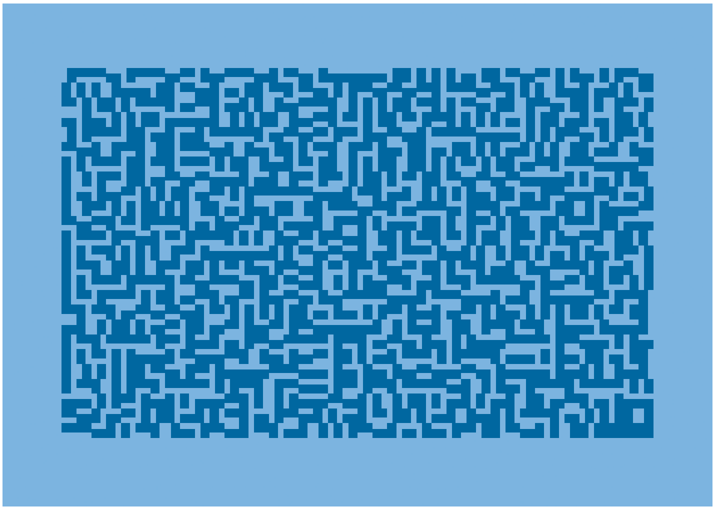

Figure 15.5

```
10 PRINT CHR$(181+(INT(RND(1)+.5)*3)+(INT(RND(1)+.5))); : GOTO 10
```

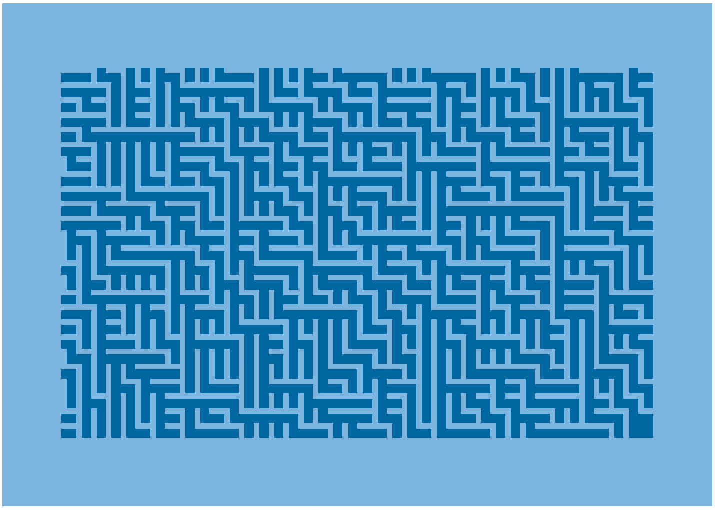

Figure 15.6

```
10 PRINT CHR$(181+(INT(RND(1)+.5)*3)); : GOTO 10
```

30
REGULARITY

REPETITION IN SPACE
THE GRID IN MODERN ART
THE COMPUTER SCREEN
REPETITION IN TIME
REPETITION IN PROCESS
PERFORMING THE LOOP

Permission was only granted to include this image in the print edition.

Figure 30.1

Vera Molnar, *Untitled (Quatre éléments distribués au hasard)*. Collage on cardboard, 1959, 75 × 75 cm. Paris, Centre Pompidou-CNAC-MNAM. © bpk | CNAC-MNAM | Georges Meguerditchian.

In 1959 artist Vera Molnar created *Untitled (Quatre éléments distribués au hasard),* a collage similar to `10 PRINT` (figure 30.1). A variant of the `10 PRINT` program shipped with the first Commodore 64s in 1982 (figure 30.2). And in 1987, Cyril Stanley Smith more or less recreated `10 PRINT`'s output from a reduced, random arrangement of Truchet tiles (figure 30.3). How did the same essential mazelike pattern come to appear in all of these different contexts in the twentieth century?

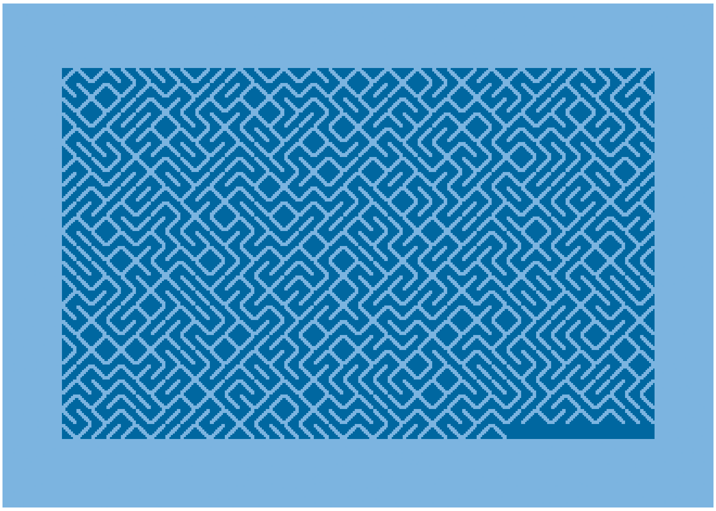

Figure 30.2

Random maze program from the *Commodore 64 User's Guide*, 1982.

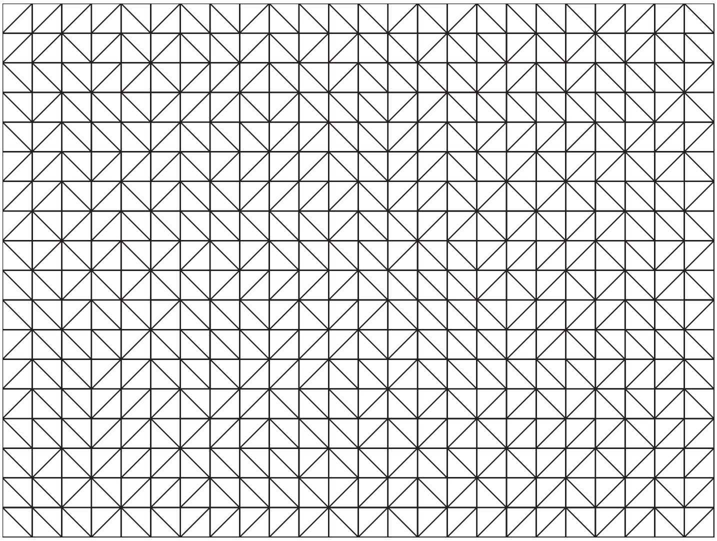

Figure 30.3

Truchet's four tiles placed in random orientations by Cyril Stanley Smith in 1987. The solid coloring was removed to show the formal connection to the `10 PRINT` pattern.

The repetitions of the 10 PRINT process are connected to two categories of artistic tradition and to the flow of control in computer programs. The first tradition within the arts is in the domain of craft, particularly pattern-based crafts such as needlework and ornamental design. The second is the creation of complex patterns using repeated procedures and a small number of elements. In this way, the aesthetic of 10 PRINT parallels experiments in painting, sculpture, sound composition, video art, performance, experimental animation, and dance. In both cases, these artistic practices owe their success to factors that also make 10 PRINT compelling: the continual repetition of a simple rhythmic procedure or rule across a regular space or time signature creating a complex and stimulating gestalt. In its minimalist and constructivist strains the world of art confronts the constraints and regularity of the *technē* of programming, which makes room for a formal definition of a repeating process that a computer can carry out. In all of its newfangled (for the 1980s) sophistication, 10 PRINT ties the computer to the homespun tradition of handicraft: stitching, sewing, and weaving.

This intersection of design craft, art, and computation is not accidental, for 10 PRINT is a demonstration of the generative qualities of repeated procedure. 10 PRINT was written and published at a time when the art world was turning to explore the constraints and possibilities of the systematization of creativity in an age of Taylorism and Fordism, of which the computational machine is itself an expression. Situating 10 PRINT not only within twentieth-century art, but also in the larger traditions of formal experimentation and craft culture can help to explain how the personal computer is a site of procedural craft.

This chapter explores the first of two formal aspects of the 10 PRINT program that give it its compelling visual power. This chapter focuses on regularity, while the next one deals with randomness. Although the pattern of 10 PRINT cannot be established at a glance, the program is nothing if not regular. It works regularly in space, time, and process—and each of these aspects of regularity is examined in the discussion that follows. Spatial regularity is considered, beginning with tilings, continuing through the history of the grid, and ending with a discussion of the computer screen. Artistic repetition in time, particularly in music and performance, is considered next. Then, repeating processes and the programming constructs that support them are discussed.

REPETITION IN SPACE

In a classic, provocative text, *The Sense of Order*, E. H. Gombrich (1994) wrestles with the tensions between pleasing repetition and uninteresting redundancy. As he reflects on pavement designs he notes the pleasure in encountering one whose pattern cannot be fully grasped. Gombrich explains this desire for variation or complexity in terms of the information theory emerging at the time, which posits that information increases in step with unpredictability (9). He goes on to speculate that the viewer examines patterns by trying to anticipate what comes next. "Delight," he writes, "lies somewhere between boredom and confusion" (9). Consider, again, the Labyrinth at Chartres as one such balance of the two.

`10 PRINT` no doubt offers similar delights, thanks to its creation of a complex pattern from a simple random alternation. As Gombrich later argues, the greatest novelties computers bring to visual design and variation are not only their ability "to follow any complex rule of organization but also to introduce an exactly calculated dose of randomness" (1994, 94). In this view, computers prove to be entrancing weavers, and the design of `10 PRINT`, as a work of pattern rather than paths, may be less like the work of Daedalus than that of Arachne.

Patterns are inextricably tied to a process of repetition. This notion is clearly demonstrated in Gombrich's commentary on "the hierarchical principle" by which units are "grouped to form larger units, which in turn can easily fit together into larger wholes" (1994, 8), or a *gestalt*. The sum of the pattern then is the result of a process. This interrelationship of pattern, perceived whole, and process becomes clear in his discussion of paving and of various methods for selecting stones. By extension, visual design relies on the process of repeating patterns across space, even if these patterns are not drawn as individual units. The regulated backdrop or foundation of these orderly patterns in Euclidean space is the grid.

The grid provides a framework within which human intuition and invention can operate and that it can subvert. Within the chaos of nature, regular patterns provide a contrast and promise of order. From early patterns on pottery to geometric mosaics in Roman baths, people have long used grids to enhance their lives with decoration. In Islamic culture, the focus on mathematics and prohibition on representational images led to the most advanced grid systems of the time, used to decorate buildings and religious texts. Grids have also long been used as the basis for architecture and urban planning. For example, it is impossible to imagine New York, the one-time city of the future, without the regular grid of upper Manhattan. (Broadway breaks this grid in ways that form many of the city's most notable public spaces.) The grid is also the basis for our most intellectual play, from chess to go, whether the design submits to or reacts against it.

The grid has proved essential to the design of computers from the grid of vacuum tubes on the ENIAC (1946) to the latest server farms that feed data to the Internet. A new era of more reliable computing was spawned in the 1950s by a grid of ferrite rings called core memory (figure 30.4). This technology works by addressing each ring on the grid to set its charge to clockwise or counterclockwise to store one bit of information. Because the information is stored as a magnetic force, it maintains its state with or without power. The grid is an essential geometry of computation.

The two-dimensional regularity of the grid is essential to the impact of `10 PRINT`, as removing a single character from the program reveals. Taking out the semicolon that indicates that each character should be drawn immediately to the right of the previous one, the symbol that wraps the program's output continually rightward across the screen, makes the importance of the grid clear (see figure 30.5):

```
10 PRINT CHR$(205.5+RND(1)) : GOTO 10
```

As a column of diagonal lines, the output does not form a maze and the vibrant pattern that encourages our eyes to dance across the screen is not established (figure 30.5). The essential process of `10 PRINT` in time is a single, zero-dimensional coin flip to pick one of two characters; when this recurs in time, it becomes a one-dimensional stream of diagonal lines that either flows quickly down the left side (if the semicolon is omitted) or moves right to wrap around to the next position below the current line and to the left. The visual interest of this program results from wrapping this one-dimensional stream of tiles into the two-dimensional grid.

Truchet Tiles

Imagine the diagonal character graphics in `10 PRINT` are painted on a set of square ceramic tiles, of the sort used for flooring. Each tile is painted

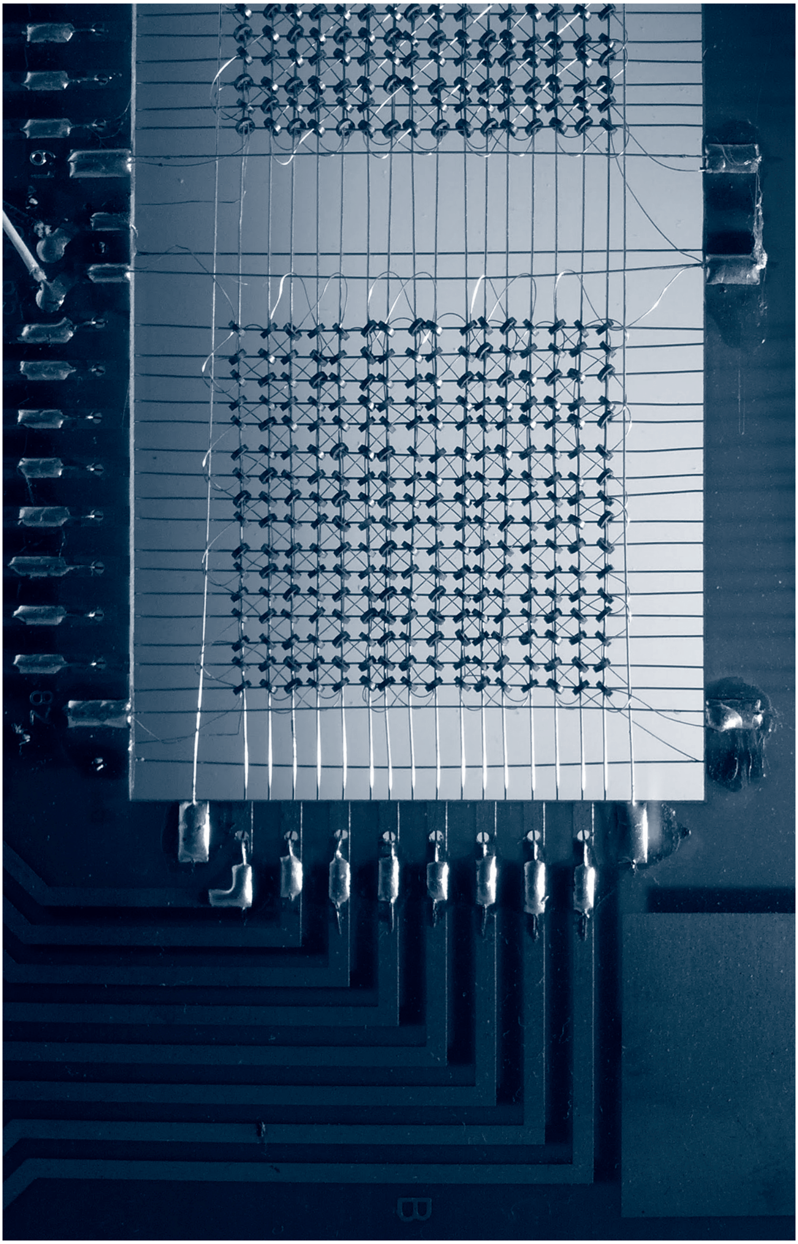

Figure 30.4

Magnetic core memory.

Figure 30.5
This screen capture from the `10 PRINT` variation without the semicolon shows the importance of the two-dimensional grid as a defining characteristic of the program.

with a black diagonal line dividing two white triangles. A tile can be rotated in two orientations, so that the diagonal line appears to be a backslash or a forward slash. Now imagine painting one of the two triangles black. Each tile can now be rotated in four different orientations, like a black arrow pointing at each of four corners. Repeatedly placing tiles down in the same orientation will create a pattern (figure 30.6). Two tiles can be placed next to each other to create one of sixteen unique formations, and laying down any such pair repeatedly will again produce patterns. Indeed, any unique grouping of tiles (whether 2 × 1, 4 × 4, etc.) can serve as a building block for larger regularity.

Now, imagine a whole floor or tapestry covered with a regular pattern of these repeating tiles. This thought exercise suggests the power of the Truchet tile, so named because the Dominican priest Sebastien Truchet first described what he called the "fecundity of these combinations" in 1704, after experimenting with some ceramic tiles he came across at a building site for a château near Orléans (Smith and Boucher 1987, 374).

Matching a single Truchet tile with another, and another, and another, and so on, a designer is able to create an incredible array of patterns. The interplay between the direction of each tile and the varying repetition of black and white—of positive and negative—produces symmetrical designs that can range from grid-like patterns to mesmerizing, almost three-dimensional illusions. Unlike earlier, Islamic patterns or Celtic designs, which both relied on multiple-sized shapes, the Truchet tile uses only a single size and a single shape (Smith and Boucher 1987, 378). In his original 1704 essay, Truchet provides examples of thirty different patterns, barely evoking the aesthetic possibilities of his tiles, though he notes that he "found too great a number to report them all" (374). Truchet's work would be the inspiration for a later book, Doüat's modestly named *Methode pour faire une infinite de desseins differents . . .* [*Method for Making an Infinity of Different Designs . . .*] which in turn had a considerable impact on eighteenth-century European art (373).

Yet all of Truchet's and Doüat's examples are regular patterns, symmetrical and repetitive. The historian of science Cyril Stanley Smith observed in 1987 that even more compelling designs can be generated from Truchet tiles if dissymmetries are introduced. What happens when the regularity of a Truchet pattern is interrupted by randomness? Smith provides one example, a block of Truchet tiles arranged at random (figure 30.3). The lattice of the basic grid is still visible, but randomness has made its mark, leaving imperfections that disrupt any nascent pattern. Unlike the symmetrical examples Truchet and Doüat give, there is no resolution to the structure. The center cannot hold, and neither can the margins. Smith next pushes the limits of the Truchet tiles' regularity by omitting solid coloring from the tiles, leaving only the black diagonal line. The four possible orientations of any given tile are then reduced to two.

These modified Truchet tiles generate a design that looks unmistakably like the output of `10 PRINT`, a program published a half decade before Smith and Boucher's article. The grid still remains—indicating the edges of each tile—but the diagonals no longer seem to bound positive or negative space. Instead, they appear to be the walls of a maze, twisty little passages, all different. In this Truchet tile-produced artifact the dynamic between regularity and its opposite come into play, suggesting that regularity is not an aspect of design that exists in isolation, but rather can only be defined by exceptions to it, by those moments when the regular becomes irregular. Rather than celebrating that `10 PRINT` "scooped" Smith,

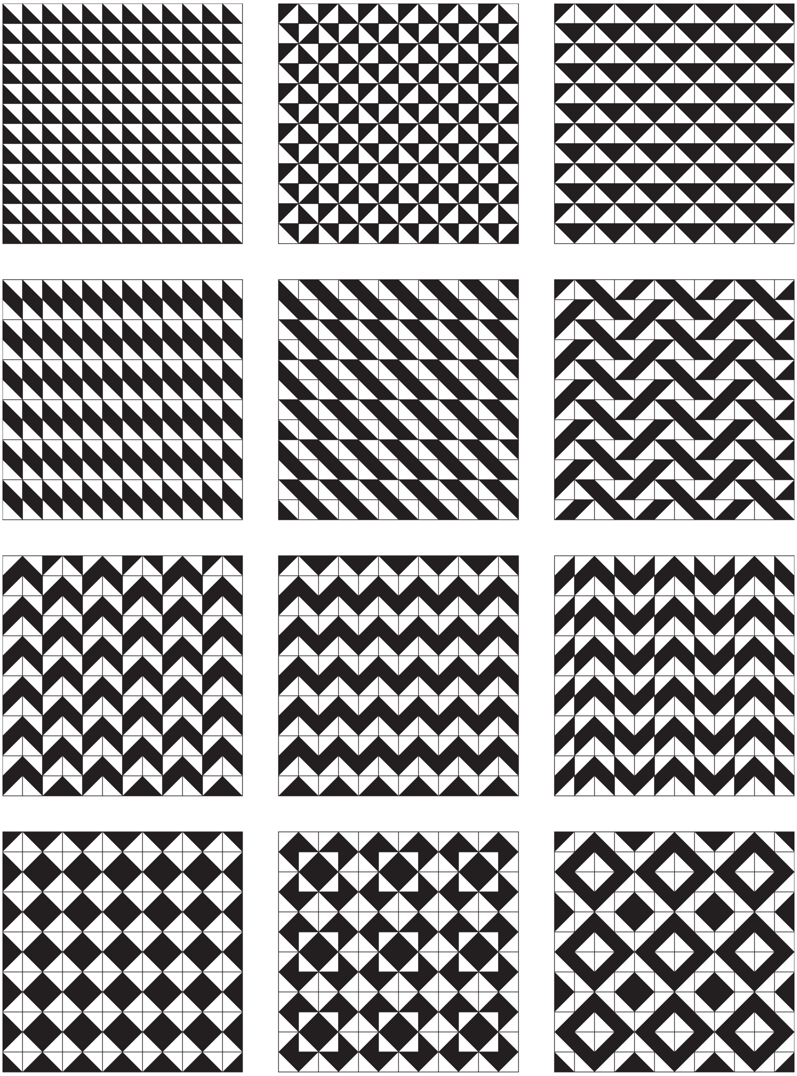

Figure 30.6

Patterns from Sébastien Truchet's "Mémoire sur les combinaisons," 1704.

Each 12 × 12 pattern redrawn above is constructed from smaller patterns using one tile design, half black and half white cut across the diagonal.

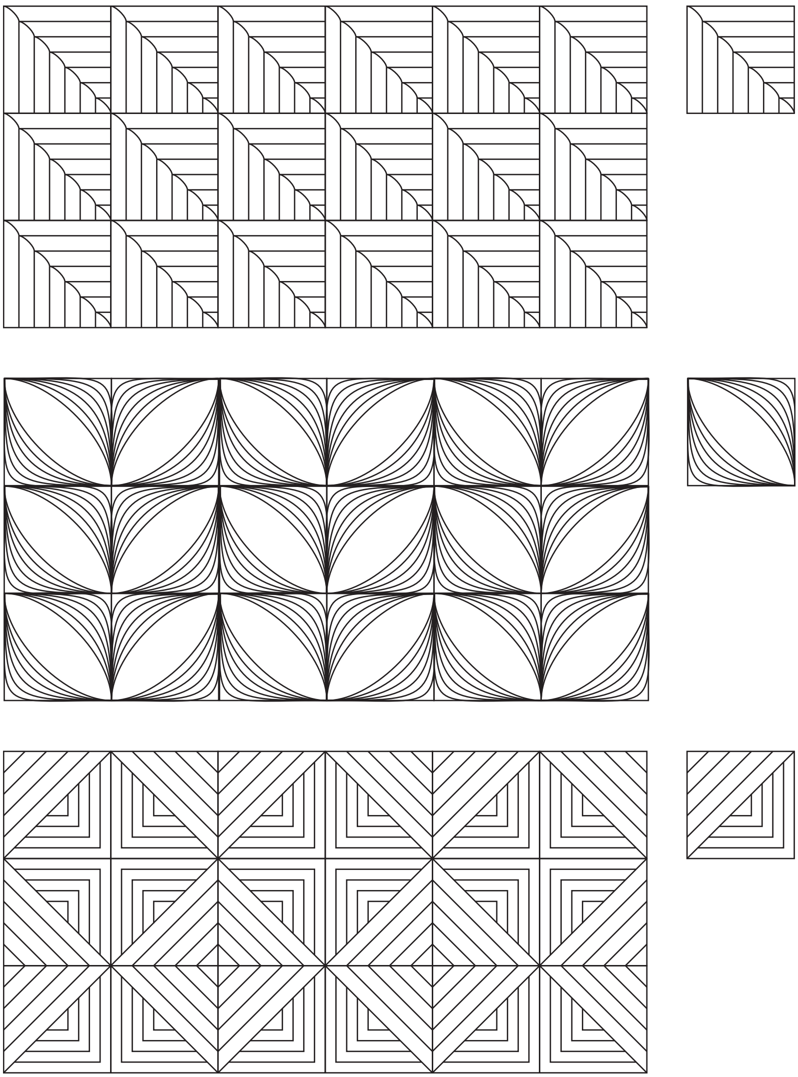

Figure 30.7
Examples of litema patterns from South Africa. These patterns are typically etched into the plastered mud walls on the exterior of homes. The patterns are constructed by repeating and rotating a single square unit.

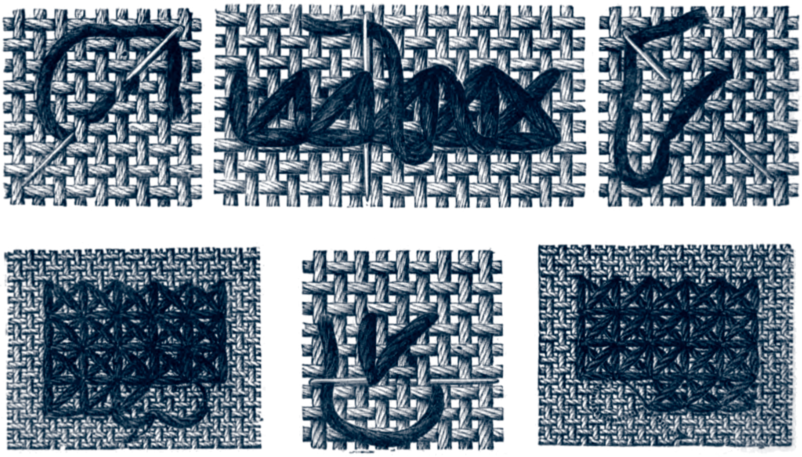

Figure 30.8
Examples of stitchwork from The Square Pattern technique from *The Young Ladies' journal Complete guide to the work-table*.

it seems appropriate to note that there are several ways up the mountain—or into the maze—of this particular random and regular pattern; one was discovered at Commodore, another by taking a mathematical perspective on tiling patterns and their aesthetics.

Textiles and Craft

The experiments of Truchet and Doüat did not introduce the idea of creating patterns out of simple variations on shapes. Such practice is commonplace across many forms of design, particularly in the realm of ornament, where both regular and irregular patterns have long been created. Franz Boas documented compelling examples of theme and variation of Peruvian weavers, for example (cited in Gombrich 1994, 72). The Kuba of Zaire create patterns of a complexity that has puzzled electrical engineers, patterns with the mazelike passageways of `10 PRINT` and yet of a far greater intricacy (Huang et al. 2005). Or consider the murals of the Sotho women of South Africa, decorative geometric murals known as *litema* (figure 30.7). This technique, documented as early as 1861, involves assembling networks of squares made of painted mud and etched with fingers and sticks

(Gerdes 1998, 87–90). In fact, the decorative arts have long held this secret to `10 PRINT`. Such techniques are detailed in the examples of fancy work in the 1885 *The Young Ladies' journal Complete guide to the work-table* (figure 30.8). The examples therein demonstrate the orthogonal basis for stitchwork that is evocative of the grid of the computer screen.

The hundreds of techniques define patterns ranging from simple grids to complex emergent patterns. As Mark Marino argues elsewhere (2010), these pattern books and instructive texts, primarily aimed at young women, provided models of fundamental processes similar to the role of the computer manuals and magazines such as *RUN.* Many of the techniques result from a repeated process with instructions, similar to that indicated by a computer program. For example, the Square Pattern technique (figure 30.8) in the Fancy Netting chapter is defined as a pair of operations that are repeated:

> No. 6.— SQUARE PATTERN
>
> For this pattern:—
> 1st Row: Work one plain row.
> 2nd Row: One ordinary stitch, and twist the thread twice round for the large square. Repeat to the end of the row.
>
> The first and second rows are repeated alternately. Arrange the stitches so that a long stitch always comes under a short stitch.

Such examples demonstrate that while the systematic theorization of patterns such as the one produced by `10 PRINT` may emerge periodically, the production of those patterns is deeply woven into the traditions of decorative craft. The fundamental role of shared techniques for process and pattern place computer programming squarely in the realm of *technē,* artistic craft. As in the *Commodore 64 User's Manual,* this text promotes the execution of a set of instructions collected as a technique. On the surface, the parallels between teaching needlecraft and programming are striking. The programmers, however, are not taught to repeat the procedure but instead, initially, to repeat a formal description of the procedure by typing it into the machine—which then does the repeating for them. It is the very automation of the process that makes `10 PRINT` possible; the program operates less like handy stitching and more like the machinery of the Jacquard Loom.

Prior to that loom, during or near the second century BCE, China gave birth to a loom "that made it possible to create a pattern in fabric . . . called a drawloom because [it] allowed the warp threads to be drawn up individually to create the design to be woven" (10). That loom, however, was irregular: "the arrangement of the individual warp threads was different for every single row of weaving" (10). By contrast, the loom designed by Joseph-Marie Jacquard was regular and programmable (12). Such a machine relied on an exacting degree of regularity. Of course, much has been made of the Jacquard Loom as the prototypical computer, for example James Essinger's book *Jacquard's Web: How a Hand-Loom Led to the Birth of the Information Age* (2004). The core similarity in these early accounts were the punch cards, which were automatically applied to the control system and which served as patterns for the loom to follow. Earlier punch card looms have been discovered and attributed to J. B. Falcon, B. Bouchon and Vaucanson, whose invention of a mechanical duck is a bit more widely known (Zemanek 1976, 16). According to Essinger, Falcon's punch cards were "clumsily made and unreliable" (36).

Commercial-grade textiles require up to four thousand cards strung together—a far cry from the two statements on the one line of `10 PRINT` (figure 30.9). The cards are applied to a bar, an "elongated cube," full of "hundreds of identical holes . . . to accommodate the tips of needles," which are raised according to the selections on the punch card. As the bar turns with each pick of the shuttle, it moves down the material as if moving down a computer screen. Regularity made it possible for the Jacquard Loom to draw its intricate patterns. But the use of the cards as a pure pattern and the inability to regulate the flow of control meant that patterns have to be defined exhaustively rather than through concise programs. In other words, the number of cards is proportional to the size of the pattern being woven. While needlework instructions demonstrate the role of repeated process and pattern over somewhat regulated space, the loom regulates time and space without, in effect, repeating the process.

`10 PRINT` can be imagined as the complete method of craft programmed into the computer—as it was not fully programmed into the loom. The loop offers a way for the weavers of the computer screen to shift their emphasis from a fixed template, traversed once, to a more intricate

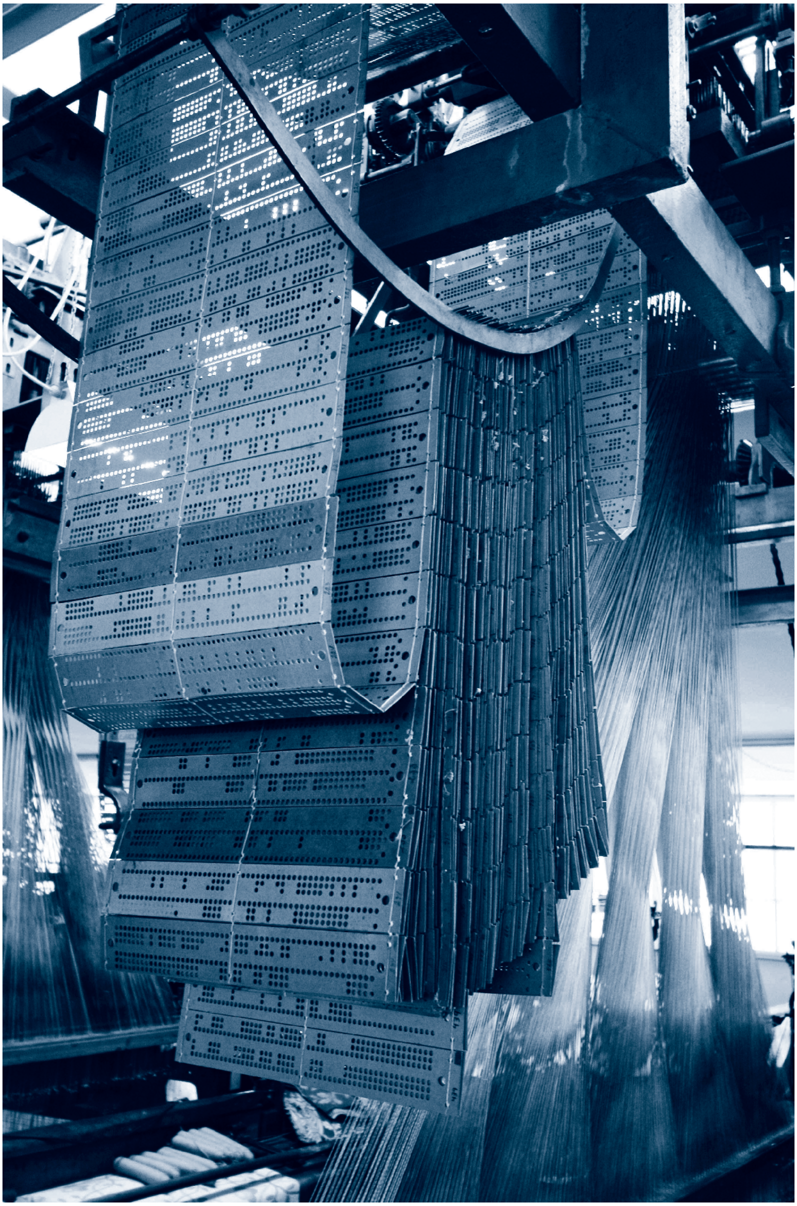

Figure 30.9

Punch card-operated loom at the Sjølingstad Uldvarefabrik in Sjølingstad, Norway. Courtesy of Lars Olaussen, Creative Commons Attribution-NonCommercial-ShareAlike 2.0 Generic.

model of process. `10 PRINT` demonstrates the power of the computational machine to rapidly prototype a repeated pattern, and since it executes the pattern itself, the incipient programmer is freed to experiment with variations and extensions of that process.

THE GRID IN MODERN ART

In the 1960s and 1970s, artists moved away from abstract expressionism, the dominant current of the 1950s, and its preference for raw emotion. Newer movements such as op-art and minimalism along with the continued line of constructivism in Europe engendered a body of rational, calculated visual art that utilized grids and even spacing to define order. A tour through any major American modern art museum will reveal Frank Stella's canvases of regular lines, Ad Reinhardt's hard-edge grids of barely distinguishable tones, Carl Andre's grids of metal arranged on the floor, Donald Judd's regularly spaced steel fabrications, Dan Flavin's florescent matrices, and Agnes Martin's exquisite, subtle grids on canvas. This list could continue for pages as it moves forward in history; the point has no doubt been made. This American tendency to move toward minimal forms was expressed well by Ad Reinhardt in "Art-as-Art" in 1962: "The one object of fifty years of abstract art is to present art-as-art and as nothing else, to make it into the one thing it is only, separating and defining it more and more, making it purer" (Rose 1991, 53).

In Europe at the same time, a massive number of artists were working with grid systems, and they were often doing so with more explicit focus and rigor. This energy was frequently channeled into groups that formed in different cities. For example, there was GRAV (François Morellet, Julio Le Parc, et al.) in Paris, ZERO (Heinz Mack, Otto Piene, et al.) based in Düsseldorf and extending a wide net across Europe, The Systems Group (Jeffrey Steele, Peter Lowe, et al.) in London, and the Allianz in Zurich (Max Bill, Richard Paul Lohse, et al.). The most iconic artist to work with grids might be the optical artist Victor Vasarely, whose grids were mesmerizingly distorted. His work was so systemized that he invented a notation system to enable a team of assistants to assemble his works using instructions and modular, prefabricated colored pieces. Although it is difficult to discern by just looking at the work, there was tension between the artists who worked toward the primacy of mathematical form and those who maintained a desire to imbue subjectivity and emotion in their geometric compositions.

In critiquing of the former category of art, Ferreira Gullar, a Brazilian poet and essayist, wrote the 1959 "Neo-Concrete Manifesto" declaring that it was dangerous for art to be concerned only with "objective problems of composition, of chromatic reactions, of the development of serial rhythms, of lines or surfaces" (Zelevanksy 2004, 57). Gullar's manifesto harkens back and reimagines works of the early twentieth century by artists such as Wassily Kandinsky, Kasimir Malevich, and Alexander Rodchenko. Within the specific context of the grid, pioneers Piet Mondrian, Theo Van Doesburg, and other artists affiliated with De Stijl abandoned representation entirely. Van Doesburg et al. coined the term "concrete art" to categorize works that are conceived without reference to nature and symbolism. The manifesto "The Basis of Concrete Painting" published in April 1930 stated, "The work of art should be fully conceived and spiritually formed before it is produced. It should not contain any natural form, sensuality, or sentimentality. We wish to exclude lyricism, dramaticism, symbolism and so forth" (Fabre and Wintgens Hotte 2009, 187). Van Doesburg continued in "Elementarism (The Elements of the New Painting)" from 1932: "One must not hesitate to surrender our personality. The universal transcends it. . . . The approach to universal form is based on calculation of measure and number" (187). Representative works such as Mondrian's *Composition with Red, Blue, Black, Yellow, and Gray* (1921) and Van Doesburg's *Counter-Composition VI* (1925) were composed exclusively with orthogonal lines to form a grid. Works from this time also experiment with rotating the grid 45 degrees to create a more dynamic composition. This formal technique manifests itself, of course, in `10 PRINT`.

While the `10 PRINT` program came out of the computer culture and not the art world, it has an uncanny visual resemblance to prior works of twentieth-century art. Paul Klee, a Bauhaus professor and highly influential artist (1879–1940), produced works in the 1920s that seemed to resume Truchet's and Doüat's experiments. In his concise *Pedagogical Sketchbook,* published in 1925, Klee presents his thoughts on quantitative structure, rhythm, repetition, and variation. His *Variations (Progressive Motif),* painted in 1927, demonstrated his theories as a visual composition. He divided the 40cm-square canvas into a grid of nine units, where each unit contains a pattern of parallel lines, with some exceptions, which run vertical, horizontal, or diagonal. More insight into this painting is found in his notebooks, as published in *The Thinking Eye* in 1964. Klee discusses the difference between natural and artificial measurement as the difference between idiosyncratic and rational order. More important, he discusses tension and dynamic density through the linear and progressive spacing of parallel lines. Through these visual contrasts in *Variations,* Klee explores the same aesthetics questions that can arise from `10 PRINT`. First he created an artificial grid to work within; then he populated each square with ordered but variable patterns. Klee didn't have the advantage of motion that is afforded to `10 PRINT`, but he simulated it through the expansion and contraction of parallel lines within his grid.

In France, a group of like-minded artists within and around GRAV (Groupe de Recherche d'Art Visuel) were exploring variations within grids. François Molnar and Vera Molnar worked on a series of images in 1959 that presented a visual system strikingly similar to `10 PRINT.` In the essay "Towards Science in Art," published in the anthology *DATA: Directions in Art, Theory and Aesthetics* in 1968, François Molnar published the images *Simulation d'une série de divisions de Mondrian à partir de trois au hasard* and *Quatre éléments au hasard*. Both are 24 × 24 unit grids with one of a few possible forms painted into each grid unit with black gouache. As the titles suggest, a random process defines the elements in each square. Their *Composition Stochastique* of the same year systematizes the random component by producing a modular set of two elements—left and right diagonals that are placed within a 10 × 10 unit grid. In the illustrations for the essay, they feature a 1 percent, 5 percent, 30 percent, and 50 percent ratio of left to right diagonal lines to show the result of chaos intruding upon order. Given that this is a 100 unit grid, these percentages correspond to precisely 1, 5, 30, and 50 units in each figure. In the 50 percent figure, the only substantive difference with our `10 PRINT` program is the variation on the core elements. So, just as a mathematician independently described the output of `10 PRINT` in 1987, a team of artists working in Paris produced the fundamental algorithm for `10 PRINT` in 1959—twenty-three years prior to the printing of the *Commodore 64 User's Guide*.

In her 1990 essay entitled "Inconceivable Images," Vera Molnar wrote that she was thinking about *Composition Stochastique* as a computer program, because she had access to a machine:

> To genuinely systematize my research series I initially used a technique which I called machine imaginaire. I imagined I had a computer. I designed a programme and then, step by step, I realized simple, limited series which were completed within, meaning they did not exclude a single possible combination of form. As soon as possible I replaced the imaginary computer, the make-believe machine by a real one.

Across the Atlantic in the 1960s the American artist Sol LeWitt embarked on decades of work exploring grids and regular structures. In 1968, LeWitt started making drawings directly on walls, rather than on paper or canvas that would be placed on the wall. In this return to the scale of frescos, his drawings within grids integrated into architecture to transform the space (Singer 1984). His *Wall Drawing 291* from 1976 is a striking work, with a strong similarity to `10 PRINT`. Instead of the binary decision within `10 PRINT`, LeWitt's drawing allows for horizontal and vertical lines, to create four choices for each grid element. LeWitt's work is encoded as an algorithm—another similarity with `10 PRINT`. A difference is that the instructions are in English, rather than BASIC:

> 291. A 12" (30cm) grid covering a black wall. Within each 12" (30cm) square, a vertical, horizontal, diagonal right or diagonal left line bisecting the square. All squares are filled. (The direction of the line in each square is determined by the draftsman.)

This grid-based wall drawing wasn't an isolated work within LeWitt's output. He created dozens of similar drawings, each with slightly different rules and allowing for varied lines including arcs and dotted lines.

While many artists and critics in the twentieth century were clearly obsessed with the grid, not all have celebrated it. The critic Rosalind Krauss put the grid into a different context in her 1979 essay "Grids" (Krauss 1979). She acknowledges the proliferation of the grid but criticizes it as a dead end: "It is not just the sheer number of careers that have been devoted to the exploration of the grid that is impressive, but the fact that never could exploration have chosen less fertile ground." She continues, "The grid declares the space of art to be at once autonomous and autotelic." Through pursuing pure visual exploration like variations on grids, Krauss argued that