

Those Peripatetic Pentominoes

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This recital is yet another case history of how the work of one man—Martin Gardner—has changed the course and pattern of a life.

In 1956 I received a gift subscription to *Scientific American* as an award for excellence in high school sciences. My favorite part of the magazine was the “Mathematical Games” column by Martin Gardner. The subscription expired after one year, and I was not able to renew it. It expired one month before the May 1957 issue, so I did not get to see the historic column introducing pentominoes (Figure 1) to a world audience.

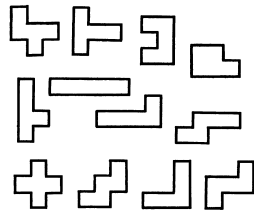


Figure 1.

That column was inspired by a 1954 article in the *American Mathematical Monthly*, based on Solomon Golomb’s presentation in 1953 to the Harvard Mathematics Club. Golomb’s naming of the “polyomino” family of shapes and their popularization through Martin Gardner’s beloved column, focusing especially on the pentominoes, created an ever-widening ripple effect.

Arthur C. Clarke, in his mostly autobiographical *Ascent to Orbit*, declares himself a “pentomino addict”, crediting Martin Gardner’s column as the source. Thwarted from including pentominoes in the movie *2001: A Space Odyssey*, as the game HAL and Bowman play (the film shows them playing chess), Clarke wrote pentominoes into his next science fiction book, *Imperial Earth*. Later editions of the book actually show a pentomino rectangle on the flyleaf.

In late 1976, a group of expatriates stationed in Iran took a weekend trip to Dubai. As we loitered around the airport newsstand, a paperback rack with a copy of *Imperial Earth* caught my eye. A longtime Clarke fan, I bought the book and soon caught pentomino fever. It was a thrill to find mention of Martin Gardner in the back of the book.

Playing first with paper and then with cardboard was not enough. I commissioned a local craftsman to make a set of pentominoes in inlaid ivory, a specialty of the city of Shiraz. This magnificent set invited play, and soon friends got involved. Exploration of the pentominoes' vast repertoire of tricks was a fine way to spend expatriate time, and inevitably a domino-type game idea presented itself to me, to be shared with friends.

Fast forward to December 1978, when the Iranian revolution precipitated the rapid evacuation of Americans. Back home I was in limbo, having sold my graphics business and with no career plans for the future. My husband's job took care of our needs, but idleness was not my style. A friend's suggestion that we "make and sell" that game I had invented popped up just then, and after some preliminary doubts we went for it.

By fall of 1979 a wooden prototype was in hand, and the pieces turned out to be thick enough to be "solid" pentominoes. Well, of course that

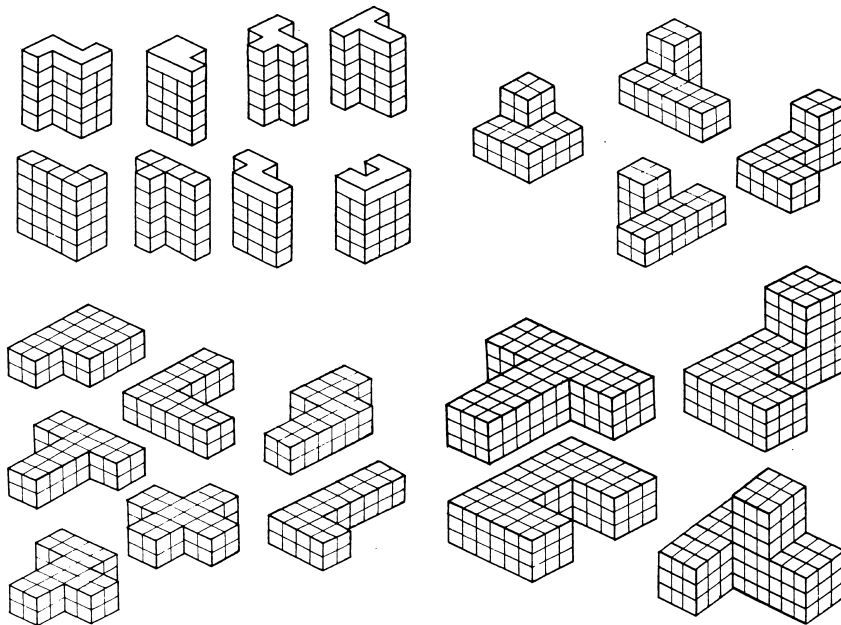


Figure 2. Super Quintillions.

was the way to go! A little research turned up the fact that “pentominoes” was a registered trademark of Solomon Golomb, so we’d have to think of another name. Fives ... quints ... *quintillions!* It was with great pride, joy and reverence that we sent one of the first sets to the inspiration of our enterprise, Martin Gardner. And it was encouraging to us neophyte entrepreneurs when *Games* magazine reviewed Quintillions and included it on the “Games 100” list in 1980.

We had much to learn about marketing. The most important lesson was that one needed a product “line”, not just a single product. And so Quintillions begat a large number of kindred puzzle sets, and most of them sneak in some form of pentomino or polyomino entity among their other activities. Here (chronologically) are the many guises and offspring of the dozen shapes that entered the culture through the doorway Martin Gardner opened in 1957.¹

Super Quintillions: 17 non-planar pentacubes (plus one duplicate piece to help fill the box). These alone or combined with the 12 Quintillions blocks can form double and triplicate models of some or all of the 29 pentacube shapes (see Figure 2).

Leap: a 6×6 grid whereupon polyomino shapes are plotted with black and white checkers pieces in a double-size, checkerboarded format. The puzzle challenge: Change any one into another in the minimum number of chess knight’s moves, keeping the checkerboard pattern (Figure 3).

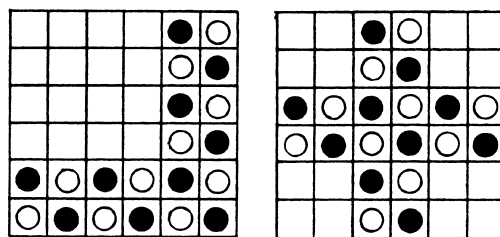


Figure 3.

¹All these are products made by Kadon Enterprises, Inc., and the product names are trademarks of Kadon.

Void: a 4×4 grid on which a “switching of the knights” puzzle is applied to pairs of polyomino shapes from domino to heptomino in size, formed with checkers (Figure 4). What is the minimum number of moves to exchange the congruent groups of black and white knights?

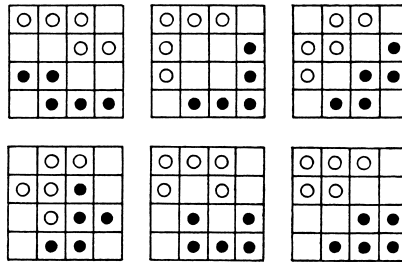


Figure 4.

Quintachex: the pentominoes plus a 2×2 square checkerboarded on both sides (different on the two sides). The pieces can form duplicate and triplicate models of themselves, with checkerboarded arrangements (Figure 5).

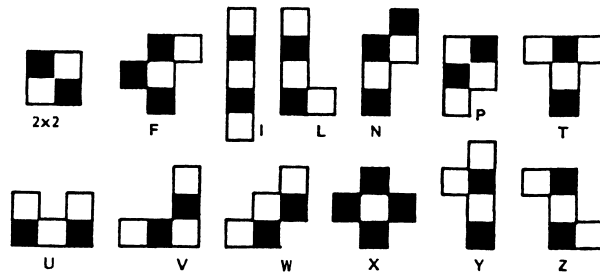


Figure 5.

Colormaze: Square tiles in six colors form double polyomino shapes with no duplicate color in any row, column, or diagonal. In another use, double polyominoes can be formed with 2×2 quadrants of each color and then dispersed through a maze-like sequence of moves to the desired final position (Figure 6).

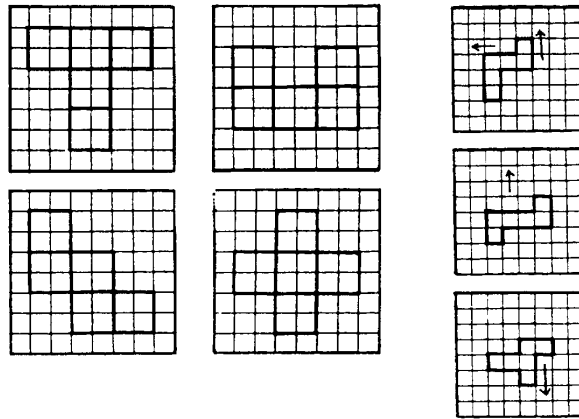


Figure 6.

Poly-5: two-dimensional polyominoes of orders 1 to 5, in a four-way symmetrical tray of 89 unit squares (Figure 7).

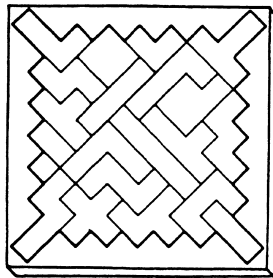


Figure 7.

Sextillions: the hexomino shapes can form double through sextuple copies of themselves and various enlargements of the smaller polyominoes. Size-compatible with Poly-5.

Snowflake Super Square: the 24 tiles are all the permutations of three contours—straight, convex, concave—on the four sides of a square. They can form various single- and double-size polyomino shapes (Figure 8).

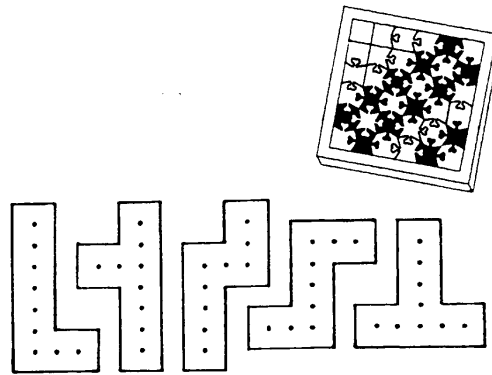


Figure 8.

Triangoes: orders 1 and 2 polytans permuted with two or more colors (square, triangle, parallelogram). The pieces can form diagonally doubled pentominoes and hexominoes with colormatching adjacency of tiles (Figure 9).

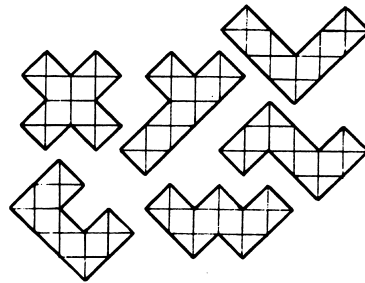


Figure 9.

Lemma: A matrix of multiple grids lends itself to polyomino packing with checkers in three colors.

Multimatch I: The classic MacMahon Three-Color Squares have been discovered to form color patches of pentominoes and larger and smaller polyominoes within the 4×6 rectangle and 5×5 square, including partitions into multiple shapes (Figure 10).

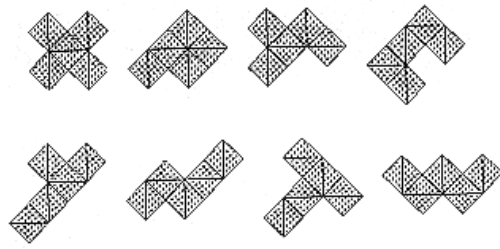


Figure 10.

Multimatch II: The 24 tri-color squares with vertex coloring (each tile is a 2×2 of smaller squares) can form polyominoes both as shapes with colormatching and as color patches on top of the tiles (Figure 11).

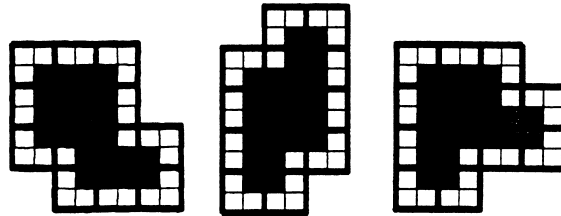


Figure 11.

Gallop: On a 6×12 grid, double checkerboard hexomino shapes defined by pawns are transformed with knight's moves (borrowed from the **Leap** set). Another puzzle is to change a simple hexomino made of six pawns into as many different other hexominoes as possible by moving the pawns with chinese-checker jumps (Figure 12).

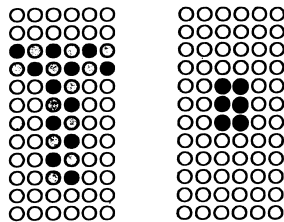


Figure 12.

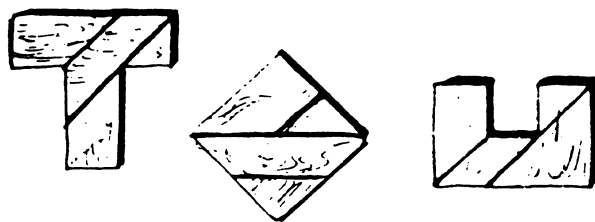


Figure 13.

Tiny Tans: Four triangle-based pieces can make some pentomino shapes. The T and U puzzles are actually dissected pentominoes (Figure 13).

Throw a Fit: Multicolored cubes form pairs of pentominoes with color-matching.

Perplexing Pyramid: A Len Gordon invention, the six pieces comprising 20 balls can make most of the pentominoes in double size.

Quantum: Pentomino and larger polyomino shapes are created by movement of pawns (the puzzles to be published as a supplement to the existing game rules).

Rhombiominos: A skewed embodiment of pentominoes, where each square is a rhombus the size of two joined equilateral triangles. The 20 distinct pieces form a 10×10 rhombus (Figure 14). This is a limited-edition set.

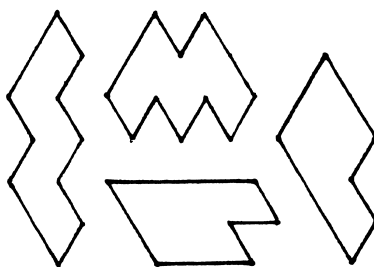


Figure 14.

Heptominoes: These sets of the 108 seven-celled polyominoes are produced by popular demand, sized to Sextillions and Poly-5.

Octominoes: The 369 eight-cell shapes exist in limited-edition sets, sized to smaller members of the family.

The Hexacube: The 166 planar and non-planar hexacube pieces plus 4 unit cubes form a $10 \times 10 \times 10$ cube. A vast territory just begging for exploration, this set is sized to Quintillions.

The above concepts arose and became possible because Martin Gardner fostered a love of mathematical recreations among his readers. A natural side-effect of his raising the consciousness of the public about the joys of combinatorial sets has been the proliferation of other sets, besides polyominoes: polyhexes, polyiamonds, polytans. All these are finding homes in the Kadon menagerie.

Throughout the years of Kadon's evolution, the inspiring and nurturing presence of Martin Gardner has been there, in the reprints of his columns, through articles in various publications, with kind and encouraging words in correspondence, and always helpful information. We were honored that Martin selected us to produce his Game of Solomon and the Lewis Carroll Chess Wordgame, using Martin's game rules. The charm, humor and special themes of these two games set them apart from all others, and we are dedicated to their care and continuance.

In retrospect, then, my personal career and unusual niche in life came about directly as a result of the intellectual currents and eddies created by one mind—Martin Gardner's—whose flow I was only too happy to follow. I cannot imagine any other career in which I would have found greater satisfaction, fulfillment and never-ending challenge than in the creation of

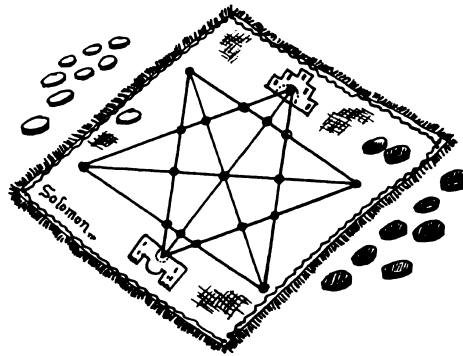


Figure 15. Game of Solomon.

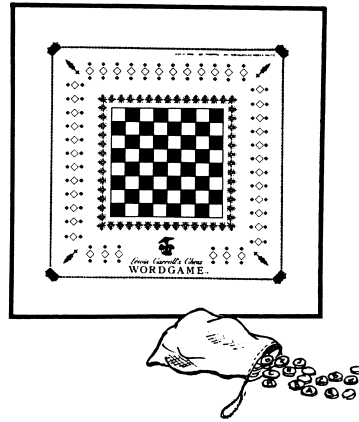


Figure 16. Lewis Carroll Chess Wordgame.

beautiful playthings for the mind. And assuredly, if there is a 90-degree angle or parallelogram to be found, the pentominoes will announce themselves in yet another manifestation. Thank you, Martin Gardner.