Martin Gardner and Scientific American:
The Magazine, Columns, and the Legacy

by Peter L. Renz

I worked with Martin Gardner as an editor and saw some of the action behind the scenes. How did those who worked with him see him? What resources did he draw upon? How did he do what he did? Here is a start at the answers to these questions.

At Scientific American. In 1974 I visited my colleagues at *Scientific American* before heading to Hastings-on-Hudson to meet Martin Gardner**.** Dennis Flanagan, editor of the magazine, told me that having columns like Martin's freed him for the trickier parts of his job. Reviewing Martin's *Colossal Book of Mathematics* in *American Scientist* in 2002, Dennis wrote that the column "was a big hit with the readers and contributed substantially to the magazine's success."

Gerard Piel, the magazine's publisher, wanted closer cooperation with it's subsidiary, W. H. Freeman and Company, where I was mathematics editor. I was sent scouting to see what Martin might suggest. Martin and I were in touch from then on, and I helped set up or sort out his publishing arrangements for him at Freeman, the MAA, and elsewhere.

In 1977 Morris Kline was putting together selections for the *Scientific American* Reader,*Mathematics: An Introduction to Its Spirit and Use* — a shorter and gentler version of his 1968 *Mathematics in the Modern World.* Morris wanted broader coverage and more elementary exposition. Martin's columns covered many basic topics, but when Morris put together the earlier reader Gerry Piel ruled them out, telling Morris that Martin controlled the rights. Freeman handled reprints and readers for the magazine then, and I knew Martin was liberal about permissions. Unlike Gerry, I was not Martin's boss, and I saw no harm in asking on Morris's behalf. Martin said, "Yes," and 14 of the 40 articles in Kline's 1978 reader were Martin's. Dennis and Gerry were protective of Martin and his material, while Martin was generous by nature. The words were his, but he saw the concepts part of a common heritage.

Your Choice: Skim or Peruse. Earlier, Morris Kline had called me about an error he spotted in a thought experiment Martin described in his April 1975 column,"Six Sensational Discoveries that Somehow or Another Have Escaped Public Attention." The experiment revealed an inconsistency in special relativity. Morris specialized in electricity and magnetism, so this got his attention. I suggested Morris look at the sixth discovery in the column, Dr. Robert Ripoff's psychic motor, popularized by Henrietta Birdbrain. We decided that Martin would handle all questions in the following month's column. (See Chapter 10 of Martin's *Time Travel and Other Mathematical Bewilderments* for the story.)

Martin's columns rewarded careful readers and skimmers. Morris looked carefully at the material that was down his alley. He skimmed the rest and it all looked looked fine to him. Thousands of readers did the same. One "discovery" was that $e^{\sqrt{136}}$ exactly equals $262,537,421,640,768,744$. The numbers match to one part in 10^{30} . Finding the discrepancy by calculation would have been difficult in 1975.

In 2007 I looked through all of Martin's columns finding the illustrators so they could be credited in new editions. This gave me a feeling for the columns: their variety and their ideal length and accessibility. I was reminded of how Martin's problems permeated the atmosphere in the column's heyday.

Editor, Artists, Management. Armand Schwab was Martin's editor at the magazine and he devised titles for the columns. Schwab and the art director lined up the artists, more than thirty over time. They are interesting. Bunji Tagawa, who did the first column, was a Sage fellow at Cornell in philosophy before turning to art. James D. Egleson was an early and frequent illustrator of Martin's columns and was famed for Hicks Mural Room at Swarthmore as well. Ed Bell, at *Scientific American* for more than 35 years and was its art director in 2010 when I was last in touch with him. He had fond memories of Martin's columns, as did Ilil Arbel, now a successful author, who illustrated many of the later columns.

Scientific American was owned by technological optimists who were committed to reason and progress. Among them were the trio who engineered the rebirth of the magazine in 1947: Gerard Piel, publisher; Donald H. Miller, Jr., general manager; and Dennis Flanagan, editor. Backing them were Bayard Ewing, Leo Gotlieb, Nathan Levin, Frazer McCann, Julius and Lessing Rosenwald, and John Hay Whitney.

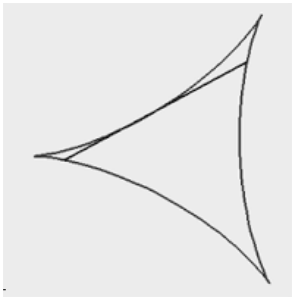
In the 1970s the magazine held its summer board meetings in San Francisco, and Freeman editors met with the directors. The directors were as keen about science and technology as they were about profits. They were tech-savvy and essential to the success of the enterprise.

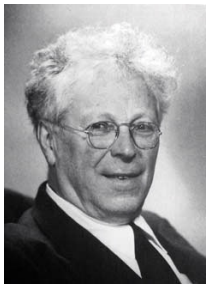
How Did He Do It? Keys to Success? A restless and powerful mind, a superb memory (even into old age), skill as a writer, and wit, and great energy. *Scientific American's* audience devoured his columns and showered him with material. Many of you read, enjoyed, thought, and responded to his columns.

How did Martin work? Partly as a reporter, getting his stories from the sources: some examples are, John Conway's Game of Life, Mandelbrot's fractals, public-key cryptography, etc. Sometimes he drew a column from a

book, for example, his April 1961 on H. S. M. Coxeter's *Invitation to Geometry*. Some columns he drew from many sources; for example, his February 1963 column, "Curves of Constant Width," cites the Watts drill for square holes, *The Enjoyment of Mathematics* by Hans Rademacher and Otto Toeplitz, and papers on "rotors" by Michael Goldberg from the *American Mathematical Monthly*. The article cites Franz Reuleaux and his triangle but not his book, *Kinematics of Machinery*. However John Grafton of Dover Publications and I believe that Martin had looked at this book and suggested the Dover reprint, which appeared in 1964.

This "curves" column ends with the Kakeya problem: What is the least area in which a needle of unit length can be rotated through 360°. Sōichi Kakeya conjectured that it was a hypocycloid of three cusps, as shown on the left below with the unit needle inside it.





On the right above is A. S. Besicovitch, who showed that a needle of unit length could be turned through 360° in as small an area as you wish. This column is Chapter 18 in *The Unexpected Hanging* and in its new edition, *Knots and Borromean Rings, Rep-Tiles, and Eight Queens* (2014). The new edition gives the construction that solves the Kakeya problem and many surprising new results connected with it. This quote gives the sense of the story:

Despite its recreational flavor, the Euclidean Kakeya problem is a central open problem in geometric measure theory with deep connections to harmonic analysis (e.g., Fefferman's result on the convergence of Fourier series in higher dimensions) and other important problems in analysis. Proving the Euclidean Kakeya conjecture (which is widely believed) seems notoriously difficult, and most progress on it is via combinatorial "approximations." — from "Kakeya Sets: New Mergers and Old Extractions" by Zeev Dvir and Avi Wigderson in *The 49th IEEE Symposium on the Foundations of Computer Science* (2008).

Lasting Impact, Long Tail. Recreational problems often tie into deeper mathematics, as the Kakeya example shows**.** Looking at Martin's columns, I am struck by their lasting interest. Flexagons, the Game of Googol or Secretary Problem, and the Unexpected Hanging launched small industries after they appeared in the column. We will be chewing on new forms of puzzles Martin popularized for decades. Martin's trapdoor cipher column altered the cryptographic landscape. His columns on Conway's Game of Life fired interest in cellular automata. His columns on *Godel, Escher, Bach* and *The Planiverse* helped popularize the work of Douglas Hofstadter and A. K. Dewdney, who went on to became *Scientific American* columnists.

Sources, People. Martin mined gold from the New York Public Library and gleaned treasures from his correspondents. Material from more than 1500 of them can be found in the Martin Gardner Papers at Stanford's library. Stan Isaacs went through the archive and identified each item for the Guide to Martin Gardner Papers, which is now available online. The Papers take up 60 feet of shelves. Look at the PDF to get a sense of who contributed to the column and how Martin organized the material.

There is treasure in this collection. Don Knuth spent two weeks combing these files when he visited Martin in Hendersonville, North Carolina, and later arranged for them to come to Stanford.

Bear in mind that the Stanford archive has only those files Martin kept relating to his column. He probably discarded more than he kept and his column was but a part of his complete lifework. In 1979 he wrote Don Knuth outlining a typical month when he was doing his column. He allotted two weeks to write his column and reserved two weeks for other projects — ones like *The Annotated Alice*.

I looked through Stan Isaac's Guide to get a feel for the material. John Conway, H. S. M. Coxeter, and Solomon Golomb have the most citations. Other groups sprang to my eye. Artists and writers, among whom there were: Isaac Asimov, L. Sprague de Camp, M. C. Escher, Piet Hein, Scott Kim, Gershon Legman, Frederick Pohl, Constance Reid, and Carl Sagan. Other *Scientific American* columnists included were: A. K. Dewdney, Douglas Hofstadter, James R. Newman, Ian Stewart, and Jearl Walker. Some giants I noticed were: P. A. M. Dirac, Oskar Morgenstern, John Nash, Linus Pauling, Roger Penrose, Claude Shannon, John Tukey, Stanislaw Ulam, Marilyn vos Savant, Scott Morris, Will Shortz, and Mel Stover. These are some names that jumped out at me; if you look, you will see others, some expected and some quite surprising.

Legacy: Continuing Contributions . Thinking and writing were Martin's joys. He could not rest from them. After his wife died in 2000 he was depressed and told me he probably wouldn't write any more books. What does the record show? From 2001 on he published 22 books and 78 articles, reviews, or magic tricks.

Martin gathered his Mathematical Games columns into 15 books and found on the MAA CD, *Martin Gardner's*

Mathematical Games. In 2006 he made arrangements for second editions. This is a joint project of the the Mathematical Association of America and Cambridge University Press. After Martin's death in 2010 his son James made arrangements with *Scientific American* allowing the project to be completed by using Martin's files and contributions from others. David Tranah, editorial director of Cambridge University Press, is spearheading this effort.

The Gatherings 4 Gardner and Celebration of Mind carry on in Martin's tradition. Martin's support of other authors shows in his blurbs and reviews. He defended reason and rooted out folly of every sort. He was my first source for news of political folly or hypocrisy. He crusaded against injustice based on intellectual fraud. See, for example, "False Memory Wars" in *The Skeptical Inquirer*, reprinted in *The Jinn from Hyperspace*.

Martin was a Platonist, and he critiqued humanist or relativist views of mathematics. See his review of Philip Davis and Ruben Hersh's *The Mathematical Experience*, in *The New York Review of Books*. He also critiqued reform mathematics textbooks in the same publication. Search under "The New New Math." We disagreed about Platonism, and other things, but his barbs were aimed at my ideas, not my person. So far as I knew, Martin harbored no animus against those whose ideas he attacked.

The delight he took in intellectual play, his regard for reason, his interest in and sympathy with human foibles, and his skill and productivity as a writer enriched us all these sixty years, and they will continue to do so for decades to come. It was a pleasure to have known him.

The books. Martin Gardner collected his Mathematical Games columns into fifteen books. The brief titles of these are listed below in the order of the Mathematical Association of America's CD *Martin Gardner's Mathematical Games*. Brief titles are used and 1/e indicates the first edition title and 2/e the second.

1. **1/e** *The Scientific American Book of Mathematical Puzzles . . .* (1959); **2/e** *Hexaflexagons, Probability Paradoxes, and the Tower of Hanoi. . .* (2008).

2. **1/e** *The 2nd Scientific American Book of Mathematical Puzzles . . .* (1961) **2/e** *Origami. Eleusis, and the Soma Cube . . .* (2008).

3. **1/e** *New Mathematical Diversions from Scientific American, etc.* (1966); **2/e** *Sphere Packing, Lewis Carroll, and Reversi. . .* (2009).

4. **1/e** *The Unexpected Hanging and Other Mathematical Diversions* (1969); **2/e** *Knots, Borromean Rings, and Eight Queens* (2014).

► Suggestions for the books from this point forward are in order as of April 2016. These should be sent to David Tranah at Cambridge University Press or to me, Peter Renz.

5. **1/e** *Martin Gardner's Sixth Book of Mathematical Games. . .* (1971); **2/e** *Klein Bottles, Op-Art, and Sliding-Block Puzzles. . ..* **Note.** There was a short collection of Dr. Matrix columns, *The Numerology of Dr. Matrix*, before the *Sixth Book*, but these columns were combined with others in *The incredible Dr. Matrix*, which is Book 9 listed below.

6. **1/e** *Mathematical Carnival* (1975); **2/e** *Sprouts, Hypercubes, and Super Ellipses. . ..*

7. **1/e** *Mathematical Magic Show* (1977); **2/e** *Nothing and Everything, Polyominoes, and Game Theory. . ..*

8. **1/e** *Mathematical Circus* (1979); **2/e** *Random Walks, Hyperspheres, and Palindromes. . ..*

9. **1/e** *The Incredible Dr. Matrix* (1978); **2/e** *Words, Numbers, and Combinatorics: Martin Gardner on the Trail of Dr. Matrix.*

10. **1/e** *Wheels, Life and Other Mathematical Amusements*, (1983); **2/e** *Wheels, Life, and Knotted Molecules. . .*

11. **1/e** *Knotted Doughnuts and Other Mathematical Entertainments*, (1986). **2/e** *Knotted Doughnuts, Napier's Bones, and Gray Codes. . ..*

12. **1/e** *Time Travel and Other Mathematical Bewilderments* (1988); **2/e** *Tangrams, Tilings, and Time Travel. . ..*

13. **1/e** *Penrose Tiles to Trapdoor Ciphers* (1989); **2/e** *Penrose Tiles, Trapdoor Ciphers, and the Oulipo. . ..*

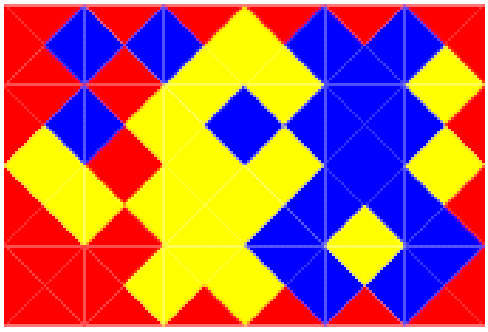
14. **1/e** *Fractal Music, Hypercards, and More . . .* (1992); **2/e** *Fractal Music, Hypercards, and Chaitin's Omega. . ..*

15. **1/e** *The Last Recreations, Hydras, Eggs, and Other Mathematical Mystifications* (1997) **2/e** *Hydras, Eggs, and Other Mathematical Mystifications. . ..*

What the new editions showed us. Martin Gardner kept files on his columns noting new results. When the columns were collected into books he regrouped his files by book. Not all of these new developments can be handled at the level of Martin's books, but much can be illustrated or pointed to. The treatment of the Kakeya problem in Book 4 is an example of this. Martin and I went to the Editorial Board listed in the new editions, especially to John Conway, Richard Guy, and Don Knuth.

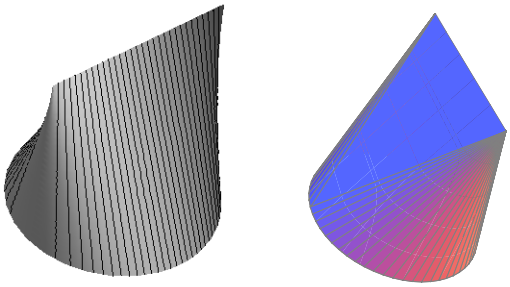
Computers and the Web changed everything. Curves that artists drew can be explored on screen. Variants of the Soma cube can be 3D printed. Here is an example of computing related to Chapter 16 of Book 3. MacMahon's squares quartered along their diagonals, and the quarters are coloreds red, yellow, or blue so that every

possible distinct coloring appears once. There are 24 of them, The puzzle is to make 4 x 6 rectangle so that edges that meet are the same color and the outside of the rectangle is of one color. Here is one solution:



The question is "How many solutions are there?" In Martin's column he said there was just one, mistaking what Mac Mahon had said. Readers found other solutions and sent them in. Federico Fink, working by hand in Buenos Aires, estimated that there were 12,224 solutions. This was in 1963. In 1964 Fink got Gary Feldman at Stanford to coount the solutions using a mainframe. Feldman found 12,261. This is not the end. In 1977 Hilario Fernandez Long, in Buenos Aires, did a computer count giving 13,328 patterns. This number was number later confirmed by John Harris in Santa Barbara. As Ronald Reagan suggested, "Trust, but verify."

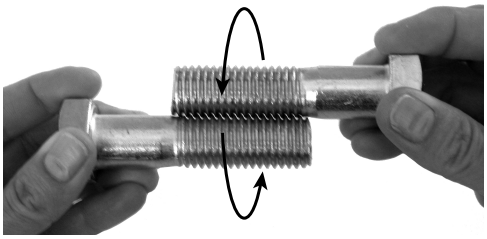
The Cork Plug, Book 5, Chapter 5, shows what computer graphics can tell us. This plug has a horizontal circular base. Above a diameter of the base raise a vertical square. The figure is filled out by taking the cross sections perpendicular to both the circular base and the vertical square to be isosceles triangles whose bases are chords of the circular base and whose apexes lie on the top edge of the square. The Mathematica™ image below, left, is the Cork Plug. The image at the right is its convex hull, slightly rotated.



Martin asked for the volume of the Cork Plug. There is a nice *Aha!* answer. He remarks that this is plug the least convex volume having three orthogonal projections that are respectively a circle, a square, and an isosceles triangle. Using Mathematica ™ to check the illustrations, I noticed that Martin's plug was not convex. Indeed, the illustration in the column showed that. So what is the least volume of convex body having these three orthogonal projections? This question is also has an easy answer. Returning to the illustration in the old edition, the figure suggests that the triangular projection is equilateral, but Mathematica ™ or thought will show this can not be.

The artists were not credited on the pages of the columns nor on those of the earlier editions of the books. Martin and I set out to identify them, credit them, and secure permission for reuse. This is a difficult task. For some images replacement was the better option. In the case of the Cork Plug, computer graphics gave a more accurate image, and the software allows readers to explore related shapes. These new editions gave us a better appreciation for how good the old illustrations were and how some can be improved.

Another example is the Twiddled Bolts, Book 2, Chapter 5. The photograph below shows the arrangement. The left and right bolts are interchangeable and they can be twiddled in either direction. The question is: When twiddled in the direction indicated will the bolts move together, apart, or keep the same distance? Note the top bolt is moving toward you while the bottom bolt is moving away. Experiment will answer the question. For *Aha!* that proves what must be true see the last line of this article.



Using photographs or computer graphics puts things in a context that invites the reader engage with the material. As these new editions come along we should expect more readers to suggest such additions. And I hope for more material on the Web. The Gatherings for Gardner and the Celebrations of Mind are the perfect places to begin the search for such contributions.

The list of books is found above. They are all available on the CD, *Martin Gardner's Mathematical Games*. We are moving ahead at Cambridge University Press, at The Mathematical Association of America, and at the Martin Gardner Littrary Trust. We look forward to your contributions and suggestions. ► **As for the bolts**, turn the page upside down. This interchanges the left and right bolt but changes nothing else. Which way will the bolts be twiddling and moving then? *Aha!*

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