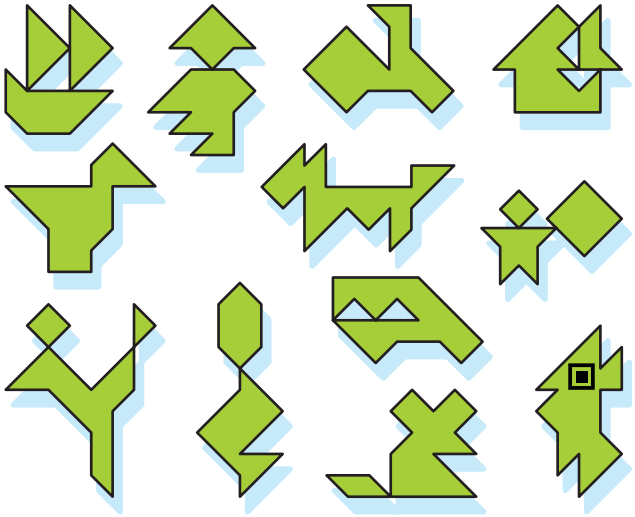
Tangram: Modern Discoveries and Achievements*

by Puzzlium

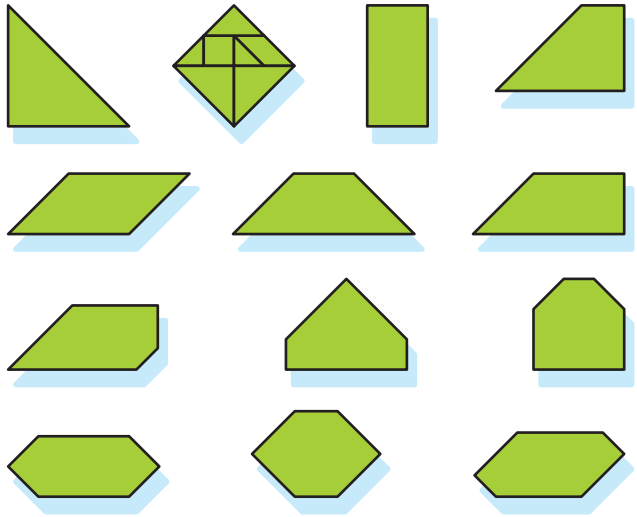
Shapes, Polyominoes, Stars, and Paradoxes

The main feature of the old classic Tangram is a possibility to create different shapes–people, animals, trees, flowers, buildings, and much more–using just seven pieces. Such shapes are very realistic and easily recognizable objects. Recently, many nice Tangram shapes have been published at Puzzlium. [2]

At the same time, Tangram hides many great, pure mathematical tasks in its deep. Say, how many convex shapes can be created of the full set of Tangram pieces. Martin Gardner [3] describes this task solved in 1942 by Fu Traing Wang and Chuan-Chih Hsiung. [4] They proved that Tangram creates exactly 13 different convex shapes. All these shapes are shown in Martin Gardner's book [5].



Tangram: Modern Shapes
A dozen of modern shapes selected from over 20,000 shapes published at Puzzlium.



Tangram: Convex Polygons
All the thirteen convex polygons possible to create of Tangram.

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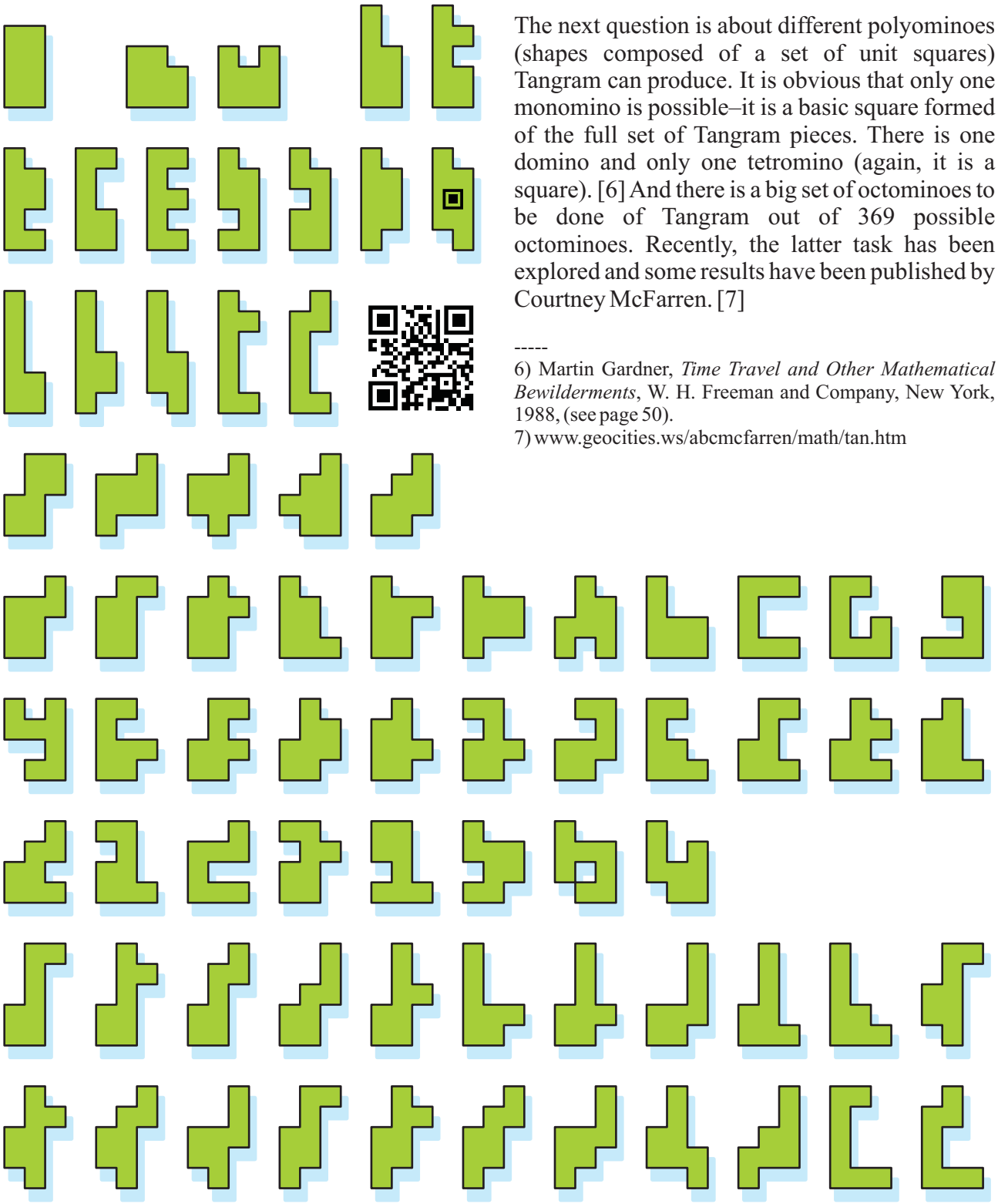
*) Prepared by Serhiy Grabarchuk, a puzzle creator, solver, writer, and co-founder of Puzzlium Inc., www.puzzlium.com.

2) Published at Puzzlium, www.puzzlium.com, 2014. Puzzlium is the biggest source of puzzles created by thousands of users from all over the World. In particular, Puzzlium proposes over 20,000 interactive Tangram challenges to play.

3) Martin Gardner, *The Second Scientific American Book of Mathematical Puzzles and Diversions*, Simon & Schuster, New York, 1961; republished in 1987 by University of Chicago Press, Chicago, (see page 214).

4) Fu Traing Wang and Chuan-Chih Hsiung, "A Theorem on the Tangram," *The American Mathematical Monthly*, 49(#9), November 1942, pages 596-599.

5) Martin Gardner, *Time Travel and Other Mathematical Bewilderments*, W. H. Freeman and Company, New York, 1988, (see page 43).



The next question is about different polyominoes (shapes composed of a set of unit squares) Tangram can produce. It is obvious that only one monomino is possible–it is a basic square formed of the full set of Tangram pieces. There is one domino and only one tetromino (again, it is a square). [6] And there is a big set of octominoes to be done of Tangram out of 369 possible octominoes. Recently, the latter task has been explored and some results have been published by Courtney McFarren. [7]

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6) Martin Gardner, *Time Travel and Other Mathematical Bewilderments*, W. H. Freeman and Company, New York, 1988, (see page 50).
7) www.geocities.ws/abcmcfarren/math/tan.htm

Tangram: Octominoes
This and the opposite pages show all 136 octominoes
(out of 369 possible octominoes) which can be done of Tangram.

That web page states that 134 octominoes out of 369 ones can be made with Tangram, but in fact it shows just 132 different octominoes. Four more octominoes (shown in yellow in the diagram in this page) were discovered by Serhiy Grabarchuk during revisiting this theme. The updated results with all 136 octominoes are presented in this and the opposite pages. It is odd enough that just a handful of octomino shapes were published in different Tangram books and playing sets during the two-century history of Tangram. [8]

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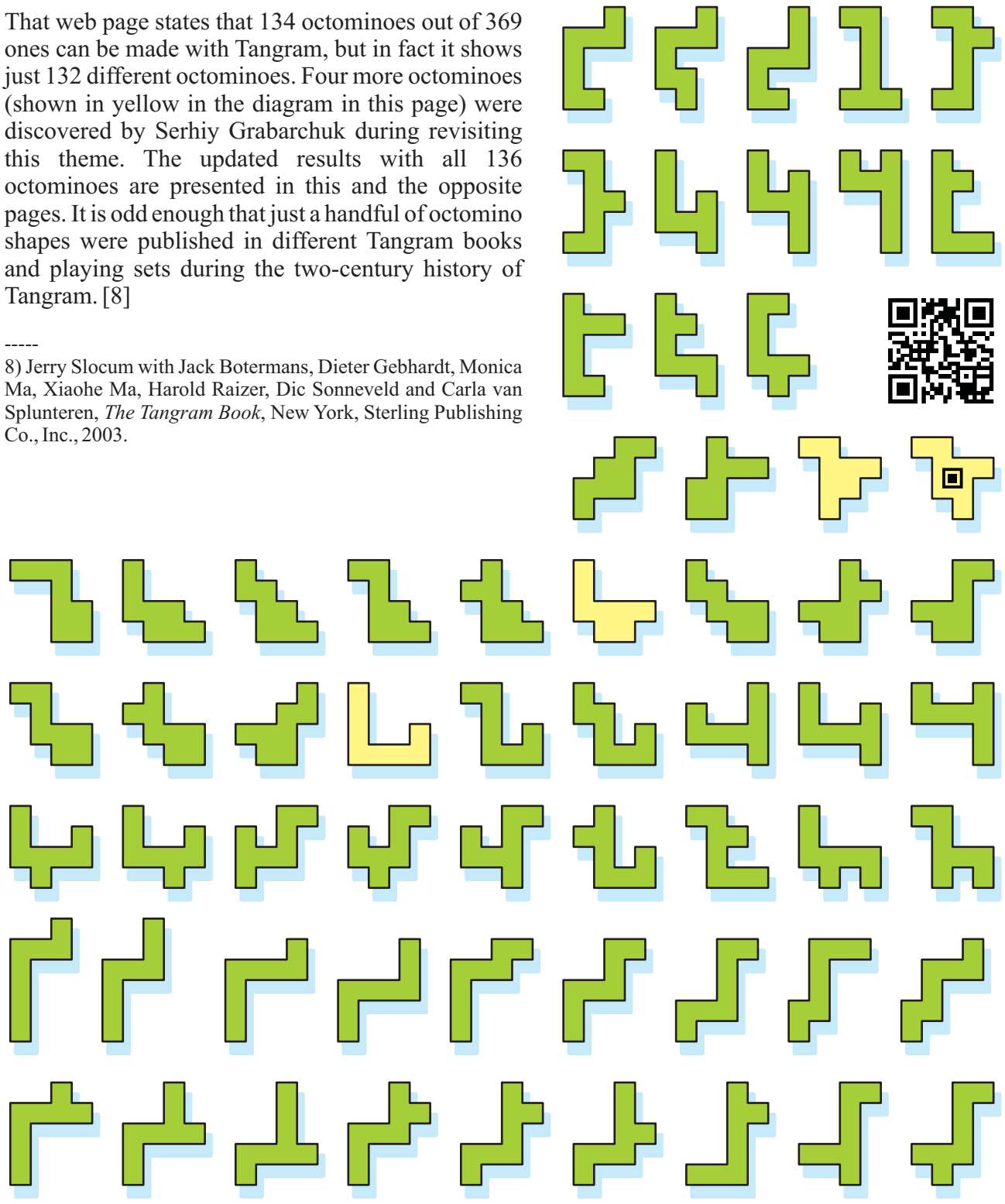
8) Jerry Slocum with Jack Botermans, Dieter Gebhardt, Monica Ma, Xiaohe Ma, Harold Raizer, Dic Sonneveld and Carla van Splunteren, *The Tangram Book*, New York, Sterling Publishing Co., Inc., 2003.



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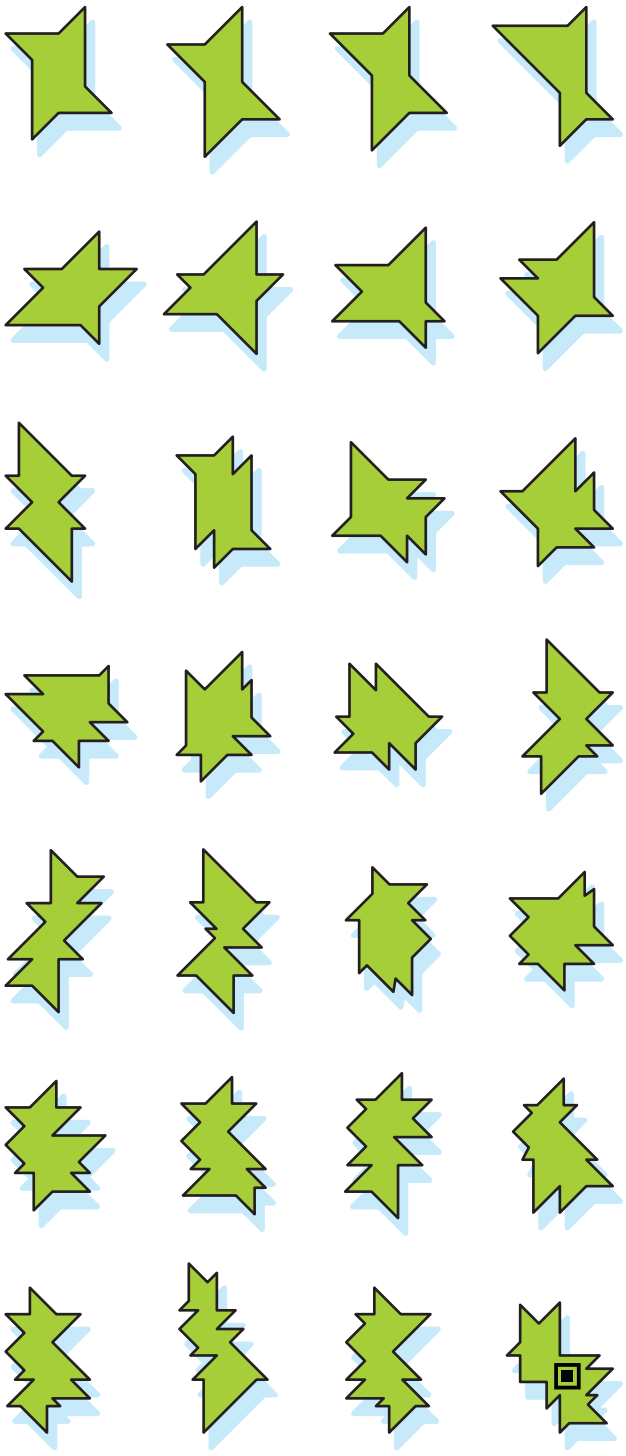

Tangram: Stars
Some stars and star-like shapes to be created of Tangram.

The most recent question about different stars or star-like shapes of Tangram was posed by Serhiy Grabarchuk in 2014. This task as well as the task with polyominoes was performed with help of Puzzlium which proposes a great tool for creating and publishing different shapes of Tangram.

A Tangram star is a plain shape whose outline is created of alternately repeating peaks and caves (convex and concave angles). Let's count as peaks right and acute angles, and call such shapes with N peaks – N-pointed stars. There are stars with 4, 5, 6, 7, 8, 9, and 10 points, which can be created of the full Tangram set. Some of them are symmetric, while most of them are asymmetric, and stars with bigger numbers of points become to look like burrs. Are there stars with more than 10 points to be created of Tangram?

Last but not least, there are a few samples of newly created geometric paradoxes with Tangram. In each paradox pair its shapes look almost identical except that one of the shapes has some additional element in it, although for each shape the full set of seven Tangram pieces is used every time. [9]

Happy Puzzling!

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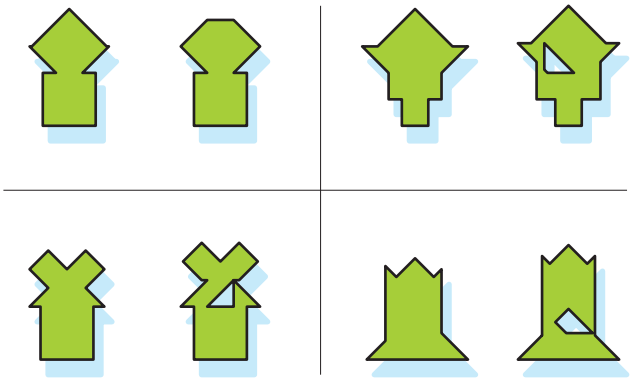
9) Published at Puzzlium, www.puzzlium.com, 2014.



Tangram: Paradoxes
Some newly created paradoxes in Tangram.

Solutions

All solutions to the above puzzles will be posted at www.ageofpuzzles.com.