Tangram

The tangram (Chinese: 七巧板; pinyin: qī qiǎo bǎn; literally "seven boards of skill") is a dissection puzzle consisting of seven flat shapes, called tans, which are put together to form shapes. The objective of the puzzle is to form a specific shape (given only in outline or silhouette) using all seven pieces, which may not overlap. It is one of the most popular re-arrangement puzzles.\[1\]

History

A modern, wooden Tangram set. They are stored, as is now common, in a square shape, as opposed to the rectangle at left.

The exact origins of the Tangram are unknown, though it is thought to be very old. It is likely that it was left unrecorded at the time of its invention due to its perceived triviality, an attitude which has since changed.\[2\] The earliest known printed reference to tangrams appears in a Chinese book dated 1813, which was probably written during the reign of the Jiaqing Emperor.\[4\]

The tans are often stored as a rectangle

The tangram was first brought to America by Captain M. Donnalson, on his ship, Trader, in 1815. When it docked in Canton, the captain was given a pair of Sang-hsia-k'o's Tangram books from 1815.\[4\] They were then brought with the ship to Philadelphia, where it docked in February 1816. The first Tangram book to be published in America was based on the pair brought by Donnalson.
The puzzle eventually reached England, where it became very fashionable. The craze quickly spread to other European countries. This was mostly due to a pair of British Tangram books, *The Fashionable Chinese Puzzle*, and the accompanying solution book, *Key*. Soon, tangram sets were being exported in great number from China, made of various materials, from glass, to wood, to tortoise shell.

One contributing factor in the popularity of the game in Europe was that although the church forbade many forms of recreation on the sabbath, they made no objection to puzzle games, like the tangram.

The word *tangram* was first used in 1848 by Thomas Hill, later President of Harvard University, in his pamphlet *Puzzles to Teach Geometry*.

In 2000, Finland issued a series of stamps in the shape of the square formed by the tangram pieces.

The author and mathematician Lewis Carroll reputedly was a tangram enthusiast and owned a Chinese book with tissue-thin pages containing 323 tangram designs. There were rumors for a time that Napoleon played the Tangram at St. Helena, but this has since been proven false.

*The Eighth Book Of Tan*, a fictitious history of Tangram, claims that the game was invented 4,000 years ago by a god named Tan. The book included 700 shapes, some of which are impossible to solve.

**Paradoxes**

A tangram paradox is an apparent dissection fallacy: two figures composed with the same set of pieces, one of which seems to be a proper subset of the other. One famous paradox is that of the two monks, attributed to Dudeney, which consists of two similar shapes, one with and the other missing a foot.
Another is proposed by Sam Loyd in *The Eighth Book Of Tan*:

The seventh and eighth figures represent the mysterious square, built with seven pieces: then with a corner clipped off and still the same seven pieces employed.\[12\]

A solution to the paradox is not reported in Loyd's book.

**Counting configurations**

Fu Traing Wang (often incorrectly cited as "Fu Tsiang Wang") and Chuan-chin Hsiung proved in 1942 that there are only fifteen **convex** tangram configurations (configurations such that a line segment drawn between any two points on the configuration's edge always pass through the configuration's interior, i.e., configurations with no recesses in the outline).\[13][14\]

Ronald C. Read's book *Tangrams: 330 Puzzles* asks the reader for any other sets of tangrams that, while more numerous than convex configurations, yet are **finite** in number.\[15\]

An estimate of 6.13 million possible "fully matched" configurations has been offered,\[16\] where "fully matched" means that at least one **edge** and at least one **vertex** of any piece is matched to an edge and vertex of another.

**The pieces**

![Tan construction diagram](image)

Sizes are relative to the big square, which is defined as being of width, height and area equal to 1.\[17\]
• 5 right triangles
  o 2 small (hypotenuse of 1/2 and sides of $\sqrt{2}/4$)
  o 1 medium (hypotenuse of $\sqrt{2}/2$ and sides of 1/2)
  o 2 large (hypotenuse of 1 and sides of $\sqrt{2}/2$)
• 1 square (side of $\sqrt{2}/4$)
• 1 parallelogram (sides of 1/2 and $\sqrt{2}/4$)

Of these seven pieces, the parallelogram is unique in that it has no reflection symmetry but only rotational symmetry, and so its mirror image can only be obtained by flipping it over. Thus, it is the only piece that may need to be flipped when forming certain shapes. With a one-sided set of tangrams (no flipping allowed), there are shapes that can be formed while their mirror images cannot.

Art

Tangram has been an object of interest to Art and Design.

The American graphic designer Paul Rand writes about the importance of tangram exercises: "Many design problems can be posed with these games in mind; the main principle to be learned is that of economy of means - making the most of the least. Further, the game helps to sharpen the powers of observation through the discovery of resemblances between geometric and natural forms. It helps the student to abstract - to see a triangle, for example, as a face, a tree, an eye, or a nose, depending on the context in which the pieces are arranged. Such observation is essential in the study of visual symbols."[18]

Some artists explicitly used tangram pieces in their works.

Donald Baechler made in 1990 a portfolio entitled "Tangram" with 8 aquatints, photo-etchings, and drypoint printed on Somerset Satin paper, signed and numbered of 34.

Patrick Scott made "Tangram I", etching with gold leaf, 31" x 30".

Matthew Langley made in 2005 several monoprints (oil on paper) on Tangram. The artist says on his blog: "I have been fascinated with tangrams ever since the second grade so I've decided to blow it right through my system and start making them. ..."

Courtney Smith made in 2008 "Tangram"[19], sculpture, furniture fragments and plywood.