The Egyptian Tangram

Activities for a new 5-piece tangram

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mmaca

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A square dissection firstly proposed as a tangram in:

Luna-Mota, C. (2019) *"El tangram egipci: diari de disseny"* Nou Biaix, 44

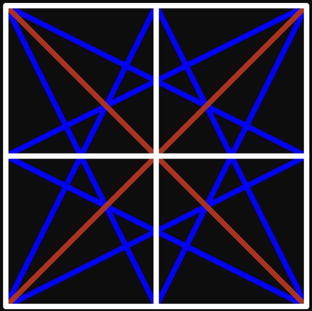
Origins

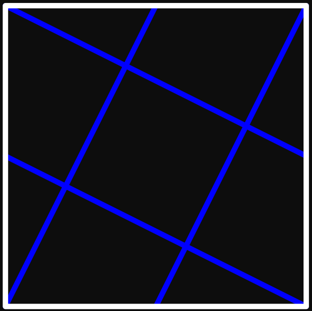
The Egyptian Tangram inspiration comes from the study of two other 5-piece tangrams...

The “Five Triangles” & “Greek-Cross” tangrams

Origins

...and their underlying grids



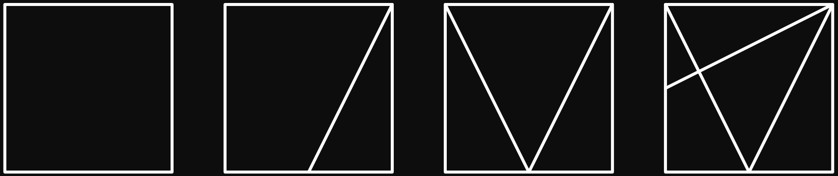


The “Five Triangles” & “Greek-Cross” underlying grids

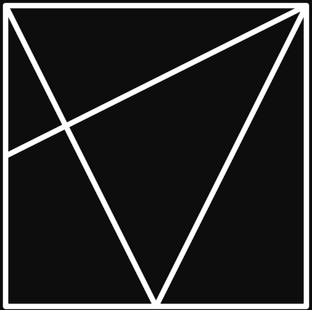
Design Process

The Egyptian Tangram was the result of
an heuristic incremental design process:

Take a square and keep adding “the most interesting straight cut”
until you have a dissection with 5 or more pieces.



Design Process



To make an Egyptian Tangram:

1. Connect the midpoint of the lower side with the upper corners.
2. Connect the midpoint of the left side with the top right corner.

Antecedents

It turns out that this figure is not new...

See problem 3 from:

Detemple, D. & Harold, S. (1996) *"A Round-Up of Square Problems"*

Mathematics Magazine, 69:1

...but, to the best of our knowledge,
nobody used it before as a tangram

Antecedents

The name is not new either...

This dissection is often called “Egyptian Puzzle” or “Egyptian Tangram”

...but there is a good reason to consider
our dissection the real “Egyptian Tangram”

(even if it was designed in Barcelona)

Antecedents

The underlying grid is also a well known figure:

Brunés, T. (1967) *"The Secrets of Ancient Geometry – and Its Use"*

Bankoff, L. & W. Trigg, C. (1974) *"The Ubiquitous 3:4:5 Triangle"*, Mathematics Magazine, 47:2

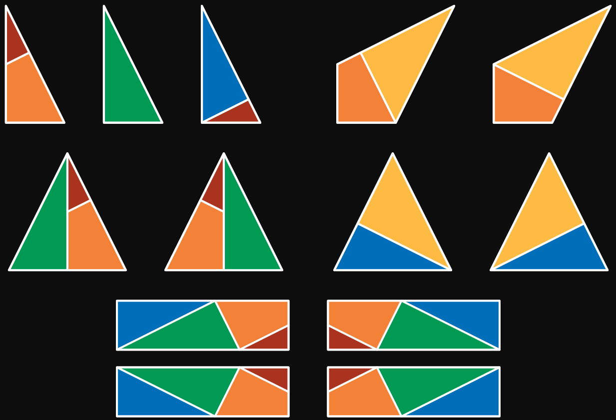
The pieces

- Just five pieces
- All pieces are different
- All pieces are asymmetric
- Areas are integer and not *too different*
- All sides are multiples of 1 or $\sqrt{5}$
- All angles are linear combinations of $90°$ and $\alpha = \arctan\left(\frac{1}{2}\right) \approx 26,565°$

Name	Area	Sides	Angles
T1	1	$1,\ 2,\ \sqrt{5}$	$90,\ \alpha,\ 90-\alpha$
T4	4	$2,\ 4,\ 2\sqrt{5}$	$90,\ \alpha,\ 90-\alpha$
T5	5	$\sqrt{5},\ 2\sqrt{5},\ 5$	$90,\ \alpha,\ 90-\alpha$
T6	6	$3,\ 4,\ 5$	$90,\ 90-2\alpha,\ 2\alpha$
Q4	4	$1,\ 3,\ \sqrt{5},\ \sqrt{5}$	$90,\ 90-\alpha,\ 90,\ 90+\alpha$

The pieces

Although all pieces are asymmetric and different, they often combine to make symmetric shapes



The pieces

This means that it is very rare for an Egyptian Tangram figure to have a unique solution

There are three different solutions for the square, and in all three cases two of the corners of the square are built as a sum of smaller angles!

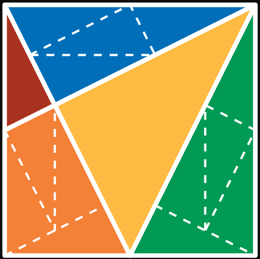
Why we called it the *Egyptian* Tangram?

The smallest pieces of the Xinese and Greek-Cross Tangrams can be used to build all the other pieces...

...but you cannot do the same with the Egyptian Tangram because of T6

Why we called it the *Egyptian* Tangram?

Initially, T6 was considered as the *leftover* piece that results from cutting all these $1:2:\sqrt{5}$ triangles from the borders of the square. But it turned out to be a very well known triangle...

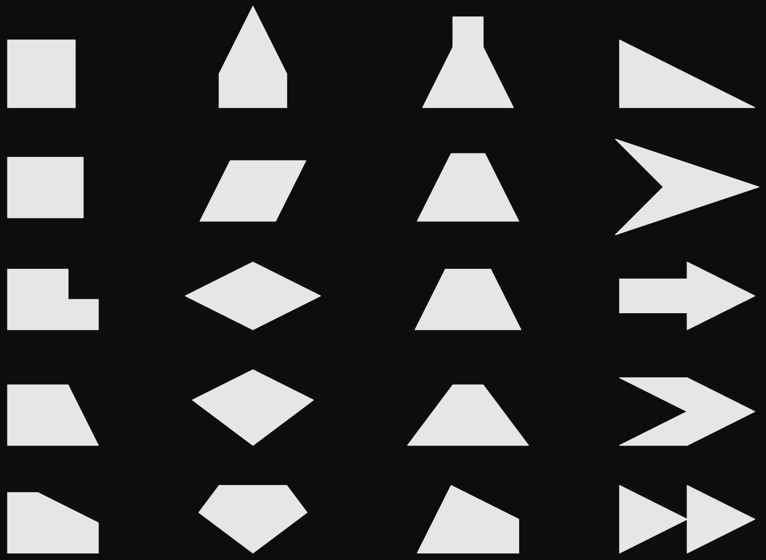


...the **Egyptian** Triangle $(3:4:5)$

and, hence, the name

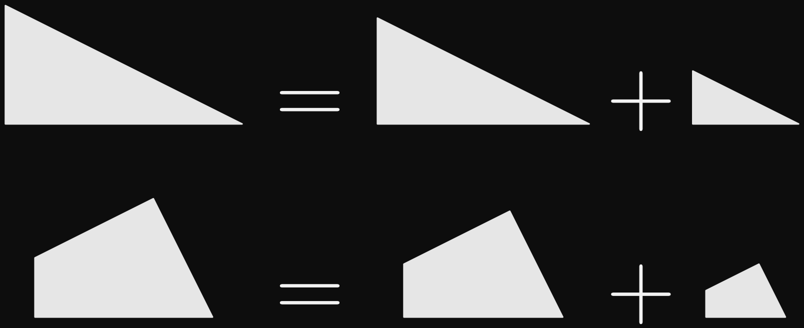
Exercices

Geometric shapes with all 5 pieces



Sum of similar figures

Use all 5 pieces to build the single figure in the LHS, then use them to build the two figures on the RHS



In both equations, the figures are similar and areas are in ratio 5 : 4 : 1

Six similar triangles

Use one or more pieces to build these six right triangles

All triangles are similar and their areas are in ratio: $20 : 16 : 9 : 5 : 4 : 1$

Geometric shapes with T1, T4, T5 & T6

Build these nine figures using just
the four triangles of the Egyptian Tangram

more exercices comming soon

References

- **Brunés – *"The Secrets of Ancient Geometry"* (1967)**
- **Bankoff & Trigg – *"The Ubiquitous 3:4:5 Triangle"* (1974)**
- **Detemple & Harold – *"A Round-Up of Square Problems"* (1996)**
- **Luna-Mota – *"El tangram egipci: diari de disseny"* (2019)**