



Mathematics and Jewish Art

A glimpse at our contribution
to an *Erasmus +* project
2016-2018

Thierry Dana-Picard and Sara Hershkovitz

International Conference on STEAM Education, Jerusalem
July 3rd, 2018



Artifacts a couple of examples

The Arch of Covenant - Exodus 25,10

Golden ratio



$$\frac{2.5}{1.5} = \frac{5}{3} = 1\frac{2}{3} \approx 1.66$$

וַעֲשׂוּ אֲרוֹן עֲצֵי שִׁטִּים
אֲמָתִים וְחֹצֵי אַרְכּוֹ וְאִמָּה וְחֹצֵי
רְחִבּוֹ וְאִמָּה וְחֹצֵי קִמְתּוֹ.

And they shall make an ark of acacia-wood: two cubits and a half shall be the length thereof, and a cubit and a half the breadth thereof, and a cubit and a half the height thereof.

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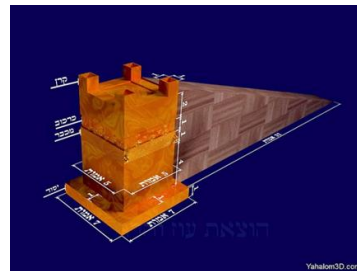
The exterior (copper) altar - Exodus 27,1

Golden ratio

וַעֲשִׂיתָ אֶת הַמִּזְבֵּחַ עֲצֵי שִׁטִּים
חֲמֵשׁ אַמּוֹת אָרְךָ וְחֲמֵשׁ אַמּוֹת
רְחִיב רְבֹועַ יְהִיָּה הַמִּזְבֵּחַ וְשִׁלֹּשׁ
אַמּוֹת קִמְתּוֹ

$$\frac{5}{3} = 1\frac{2}{3} \approx 1.66$$

And thou shalt make the altar of acacia-wood, five cubits long, and five cubits broad; the altar shall be four-square; and the height thereof shall be three cubits.



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Jewish Art: Ancient items (Translations)

Panel from a Torah Shrine from the Ben Ezra Synagogue in Cairo, 11th century, wood (walnut) with traces of paint and gilt, 87.3 x 36.7 cm (The Walters Art Museum). The patterns of vine scrolls and lozenges shows the influence of Islamic art.



Santa Maria la Blanca, former synagogue in Toledo, Spain. Erected in 1180, it may be the oldest synagogue in Europe still standing. It is now owned and preserved by the Catholic Church as a museum
photo: Nik McPhee (CC BY-SA 2.0)

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White and blue fringes (Numbers 15,38)

וַעֲשׂוּ לָהֶם צִיצִית עַל כַּנְּפֵי בְּגָדֵיהֶם לְדֹרֹתָם וְנָתְנוּ עַל צִיצִית הַכַּנֹּף פֶּתִיל תְּכֵלֶת

Speak to the children of Israel and you shall say to them that they shall make for themselves fringes on the corners of their garments, throughout their generations, and they shall affix a thread of sky blue [wool] on the fringe of each corner.

According to Maimonides (Fibonacci numbers):

At least 7 groups of 3 turns: $7 \times 3 = 21$

At least 13 groups



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Tessellations

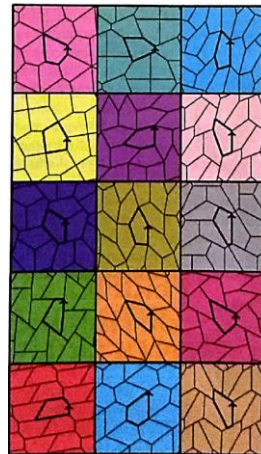
A **tessellation** of a flat surface is the tiling of a plane using one or more geometric shapes, called tiles, with no overlaps and no gaps. In mathematics, tessellations can be generalized to higher dimensions and a variety of geometries.



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A very modern issue



Michael Rao,
arXiv:1708.00274,2017

The plane can be tiled with convex pentagons (15 possibilities). Not a single periodic tiling.

What about non-convex pentagons? The question is open, it seems that it will be very difficult.

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What you see depends on your viewing angle



Floor tiling at the Science Museum,
University of Coimbra, Portugal STEAM Conference, Jerusalem - July 3rd, 2018

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Hens



Plymouth rock



Speckled Sussex



Braekel



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Kadoorie Synagogue, Porto, Portugal



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Geometrical effect due to perspective



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Religious items- Judaica (Rotations-Tessellations)

Torah Crown, 1698-99, Bolzano, Italy (The Jewish Museum, New York) "Originally dedicated to an Italian synagogue in 1698/99, this crown was later plundered during a Russian pogrom and then recovered. It became part of the collection of the Great Synagogue of Danzig in the early 20th century. In 1939, it was sent to the Jewish Theological seminary in New York for safekeeping when the Nazis' rise to power forced the Danzig Jewish community to disband."



Torah Case, Iraq, 19th-early 20th century, silver overlaid on wood, with coral set crested (The Jewish Museum, London)

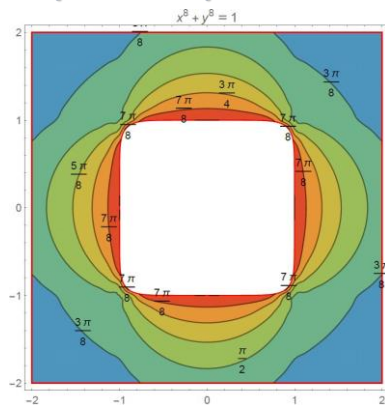
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Example: isoptics of a Fermat curve



Floor at in the lobby of an old synagogue in Budapest

Ref: Th. D-P and A. Naiman (2017): Isoptics of Fermat Curves, ACA 2017

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Jerusalem Festival of Light



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Architecture



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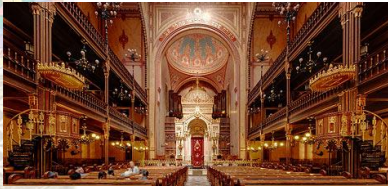


Budapest Great Synagogue (Dohany ut.)

- Symmetries and translations
- Fibonacci numbers
- Tessellations
- Affine transformations



Rundbogenstil (Round-arch style)



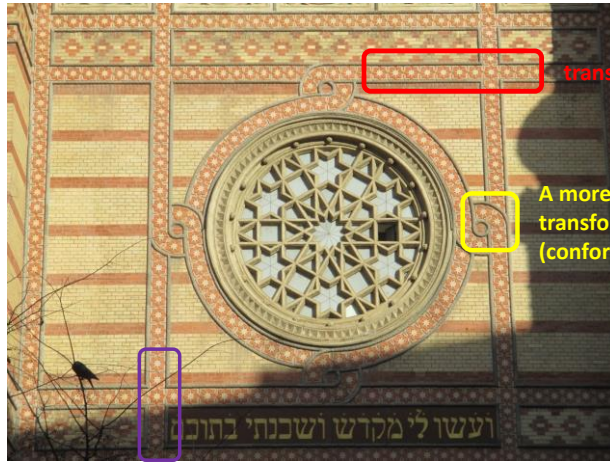
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Around the main rosette



Around the main rosette



affinity

translation

A more advanced transformation (conformal?)

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Symmetry in Tables of the Covenant



Synagogue in Lausanne



Prague: the Spanish Synagogue



The issue of the tables' symmetry has been addressed in details by **Rabbi Moshe ben Yossef di Trani** (1500-1580), one of the most important Talmudists from his time until today, in Safed (Galilee).



Source: DP-H, talk @ Symmetry Festival, Vienna 2016, and a submitted paper

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Kadoorie synagogue, Porto

rotations, translations, tessellations



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Other topics





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Computing the Jewish Calendar (lunar and solar)

An approach looking as integral calculus

Biblical length units: Fibonacci numbers

Trigonometry

Ref: DP (2014): JCRME2.



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Relevance to Mathematics Education



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- From Primary School:
 - Translations,
 - Symmetries
 - Rotations
- Mathematics does not contradict any way of life
- Talmudic thinking is mathematical by essence
- In the Talmud, we find:
 - Logic
 - Euclidean Geometry
 - Trigonometry
 - Taxicab geometry
 - Infinitesimal Calculus
 - Statistics and Probability
 - Financial maths
- Therefore: it is possible to teach Maths on the basis of Talmud and Jewish artefacts

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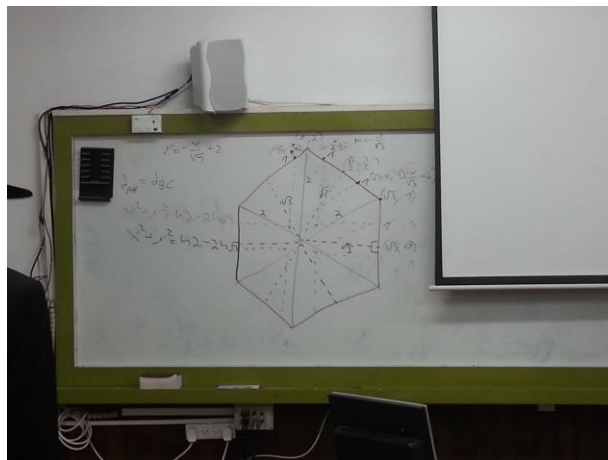
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Usage in Math Education (Hand work and Geogebra)



Study of the internal hexagon
(main façade of Budapest Great Synagogue)
Work in analytic geometry,
by pre-service teachers in Jerusalem





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A couple of references to our work

Talks and lectures:

- 2016 *The Golden Ratio – Examples from Jewish Culture*, invited poster, Bridges Finland 2016: Mathematics, Music, Art, Architecture, Education, Culture, University of Jyväskylä, Jyväskylä, Finland
- 2017 *Geometrical motives in Jewish traditional artifacts and their usage in STEM Education: One question – Three answers*, STEM conference 2017, STEM Education Centre, Johannes Kepler University, Linz, Austria. <http://mintlinz.pbworks.com/w/file/118189212/Dana-Picard%20und%20Hershkovitz.pdf>
- 2017 *Activities built with GeoGebra around traditional Jewish artifacts*, ACA 2017 – 23rd International Conference on Applications of Computer Algebra (session: [Computer Algebra in Education](#)), Jerusalem College of Technology, Jerusalem. [Book of abstracts](#), 21-22.
- 2018 Z. Lavicza, K. Fenyvesi, P. Collett, Th. Dana-Picard, S. Hershkovitz, W. Olivier, G. Tury, G. Uhl and D. Lieban - *STEAM for the Future - Integrating Hungarian, Israeli and South African Arts into Mathematics Teaching*, CADGME 2018, University of Coimbra, Portugal.
- 2018 *Tessellations – from childhood to cosmology*, CADGME 2018, University of Coimbra, Portugal.

Papers:

- 2018 *A Glimpse at Mathematics in Jewish Traditional Artefacts*, the Symmetry Journal 29 (2), 307-31
- 2018 *Geometrical Features of a Jewish Monument: Study with a DGS*, submitted to the Journal of the Mathematics and the Arts

