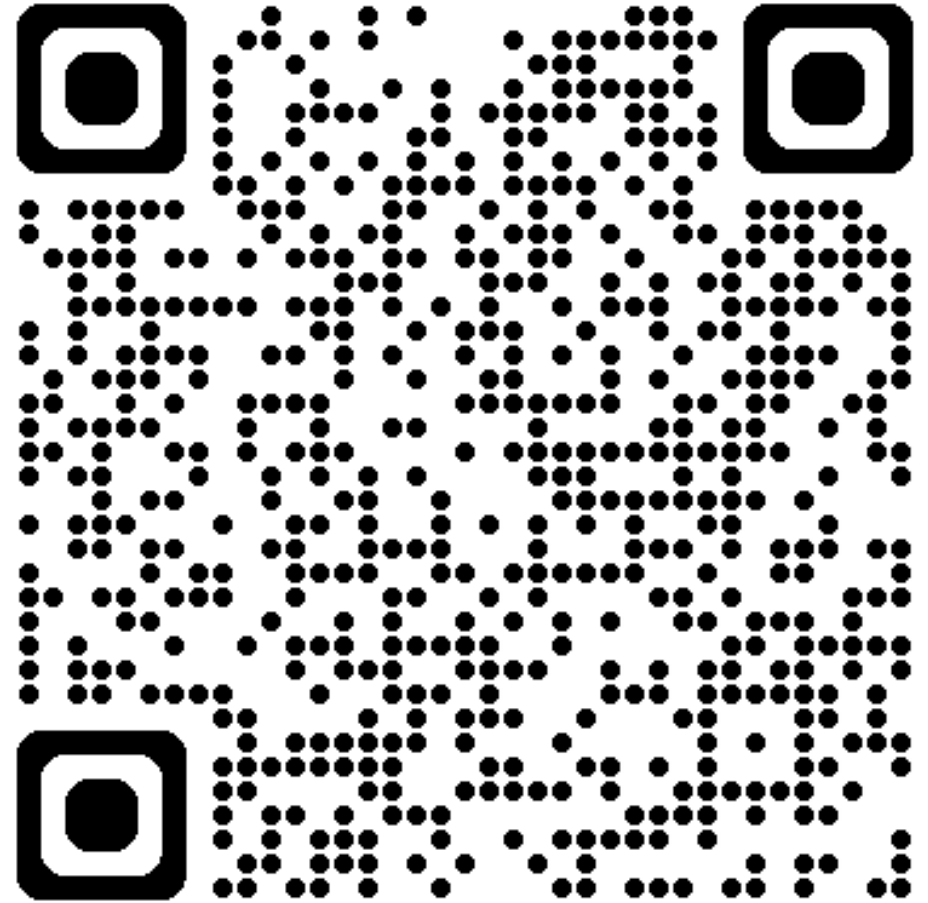
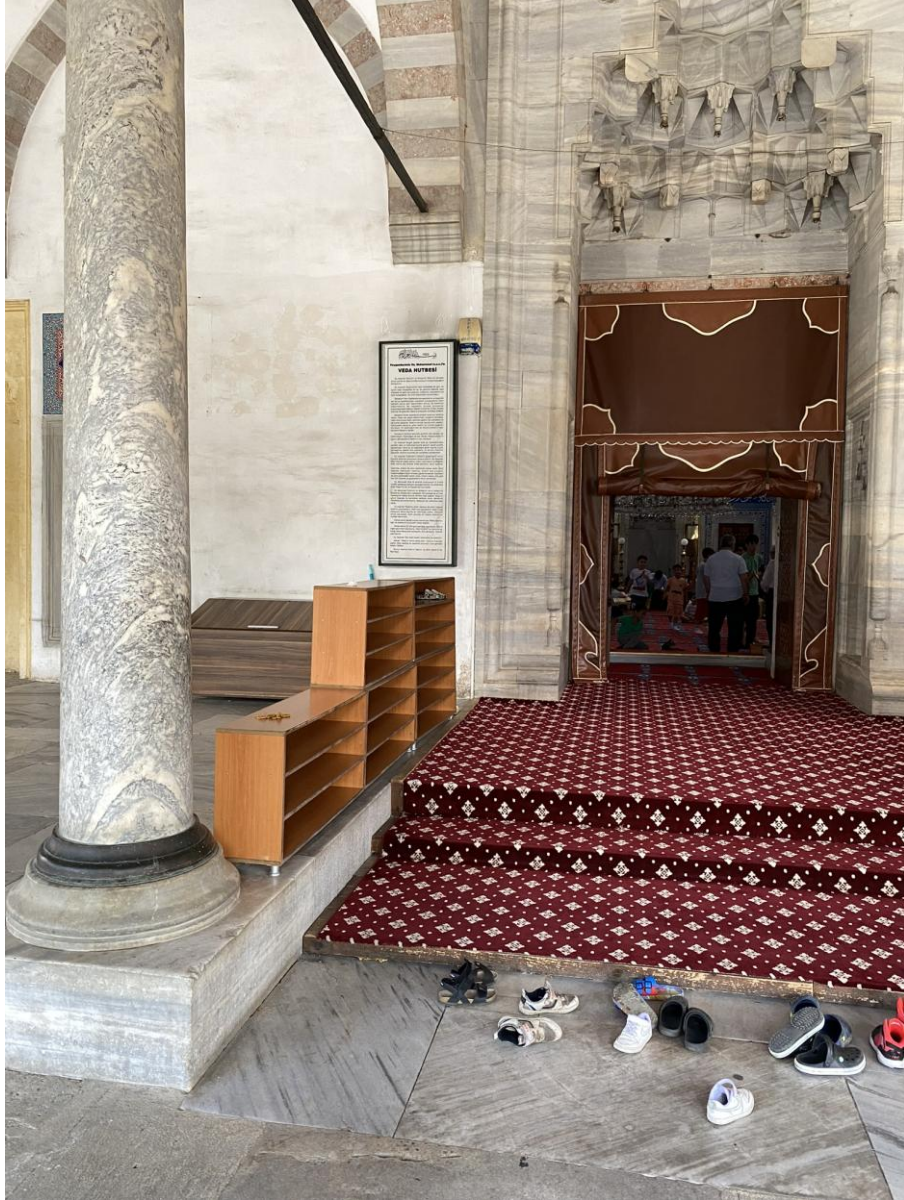


The Beauty of a Muqarnas Captured in Parameterized Software



[www . henk hietbrink . nl / muqarnas](http://www.henk hietbrink . nl / muqarnas)

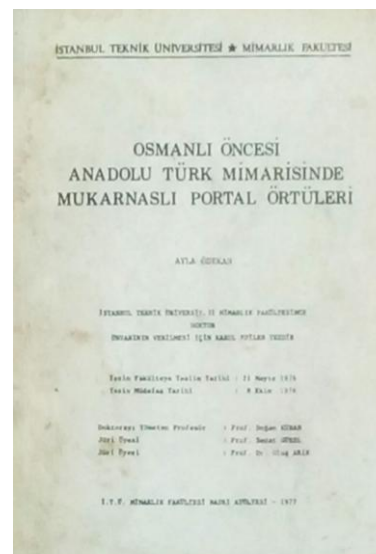
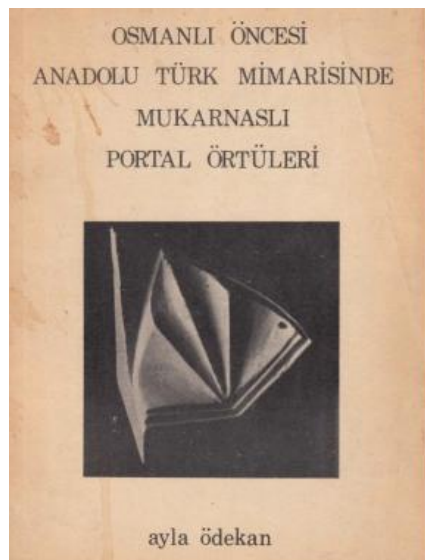
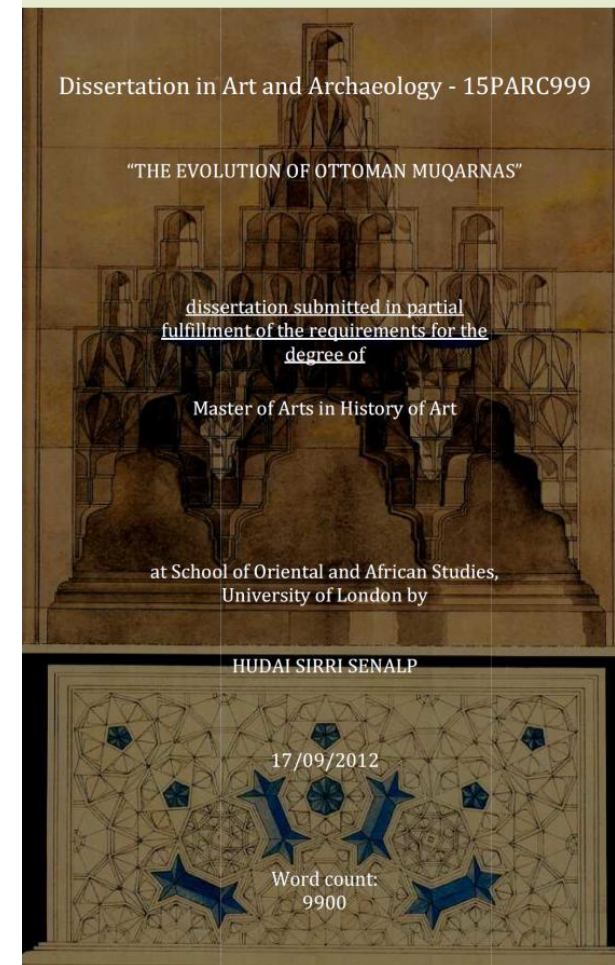
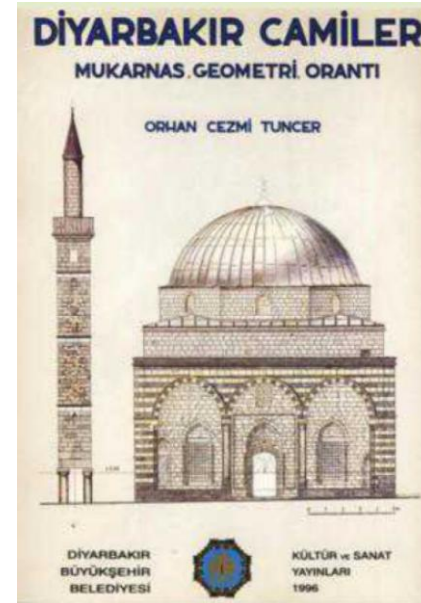
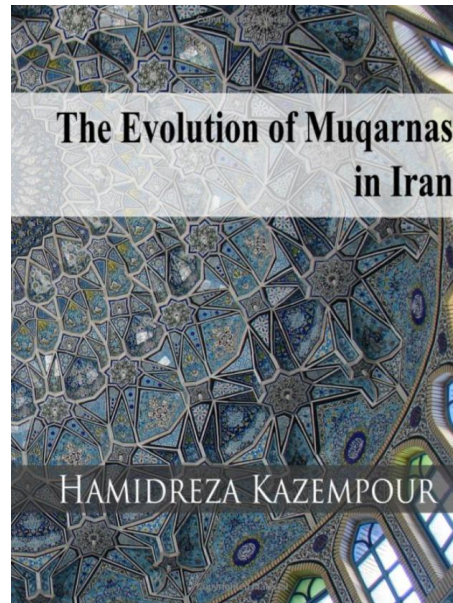
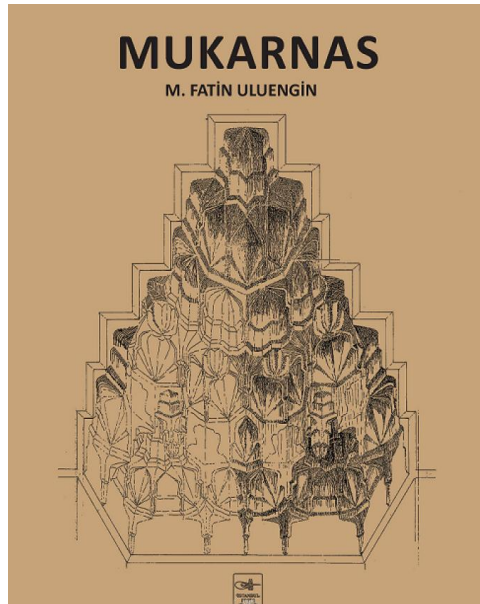
Istanbul Üsküdar Atik Valide Cami



Who are missing?



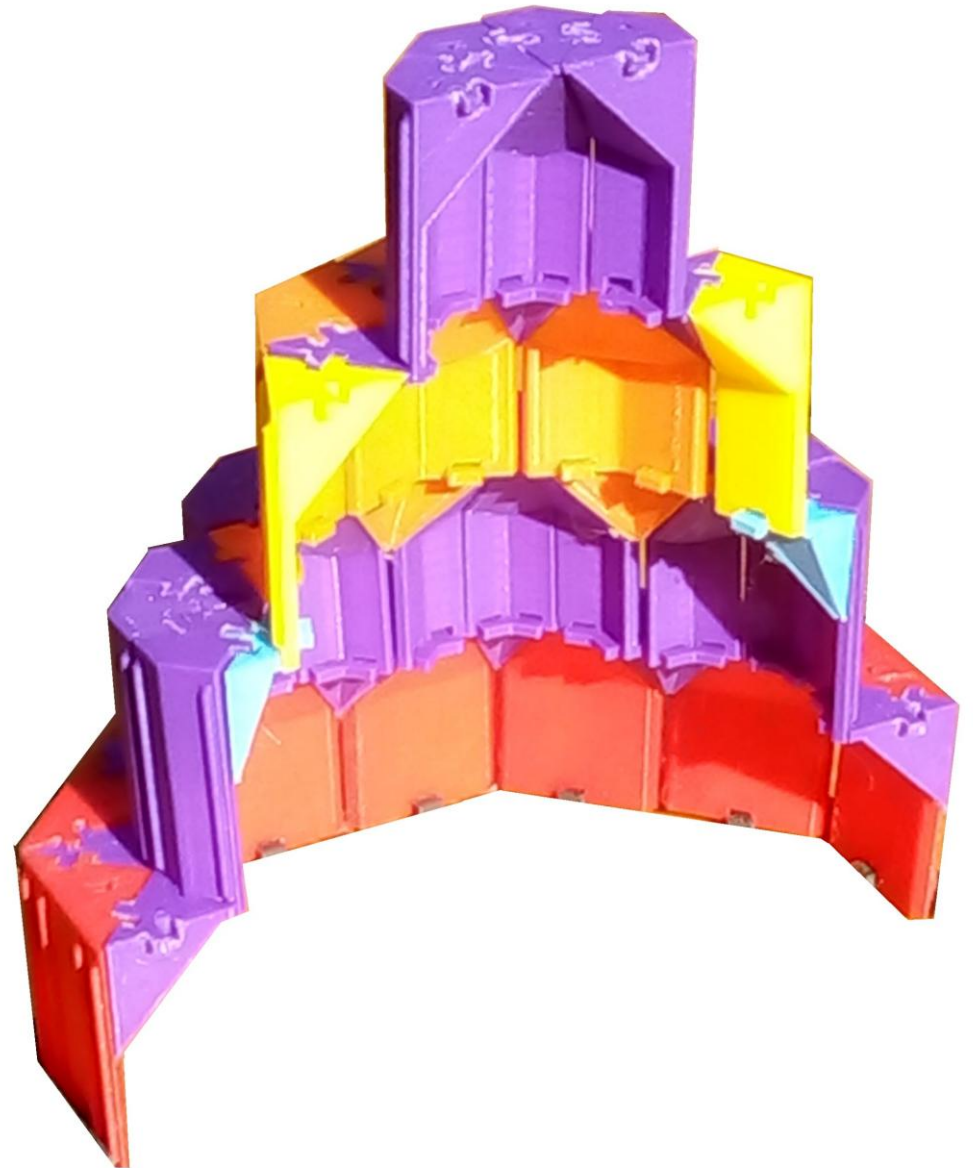
Study muqarnas: read a book



Click on a figure to open the corresponding webpage at www.henkietbrink.nl/muqarnas

Lego like units

Fun for children



Workshops in the Netherlands and in Istanbul

Fatih Sultan Mehmet Vakıf Üniversitesi
Prof. Dr. Fuat Sezgin İslam Bilim Tarihi
Enstitüsü



DESIGN A MUQARNAS YOURSELF

Atölye: Henk Hietbrink

Koordinatör: Nihal Fırat
Özdemir

Simultane Çeviri:
Rana Kahraman Duru
Rabia Odabaşı

28 Nisan Cuma

Saat 16.00

Yer: Prof. Dr. Fuat
Sezgin İslam Bilim
Tarihi Enstitüsü
Gülhane

Hemen kaydolun:
nozdemir@fsm.edu.tr



Click on a figure to open the corresponding webpage at www.henkhietbrink.nl/muqarnas

Workshops in Bursa, Konya, Istanbul

Sundials, astrolabes, conic section compass, ...



Click on a figure to open the corresponding webpage at www.henkietbrink.nl/muqarnas

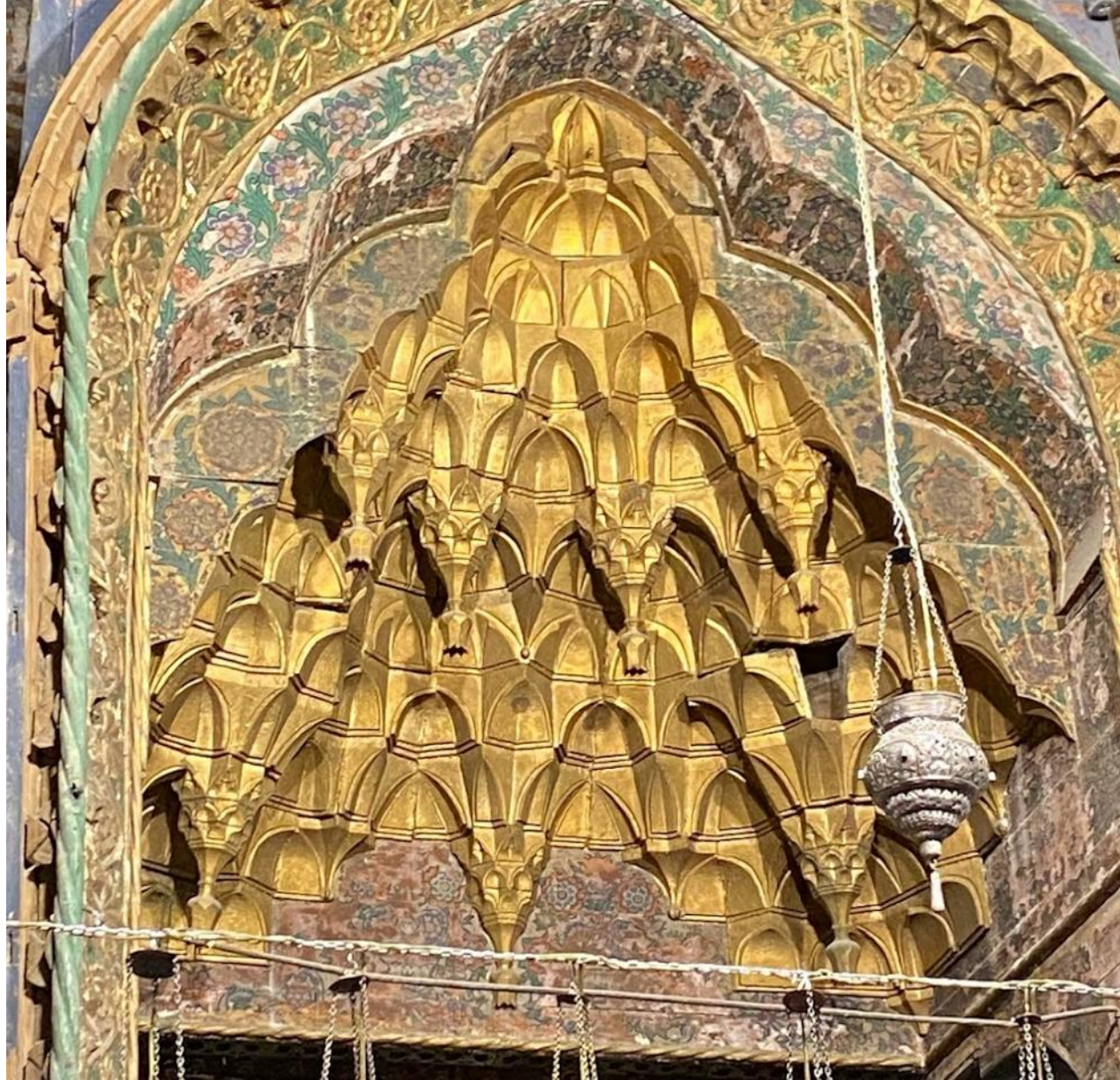
Workshops in Venlo

Sacha kept going

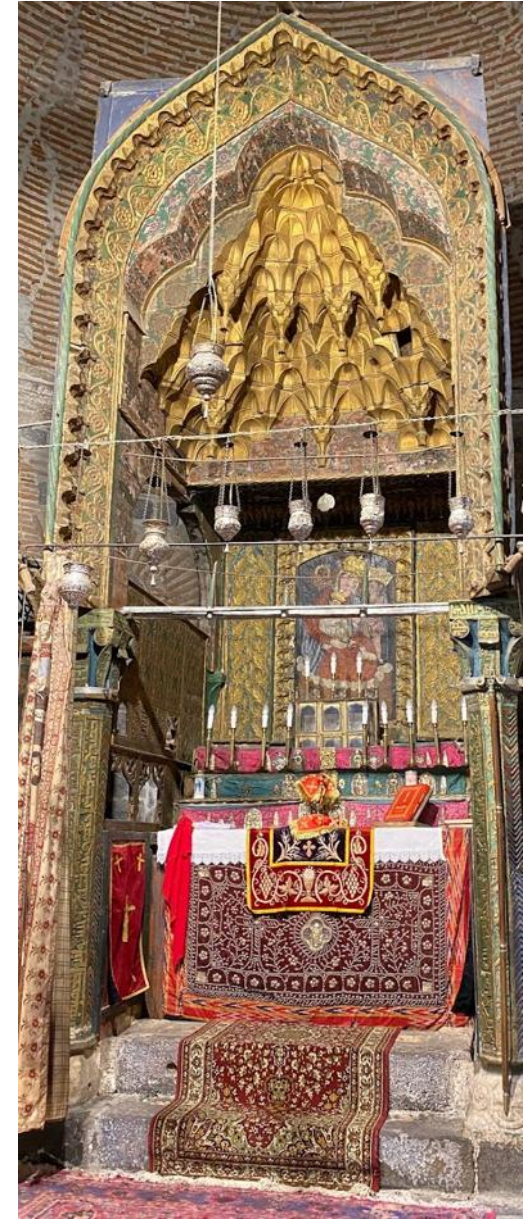


Click on a figure to open the corresponding webpage at www.henkhetbrink.nl/muqarnas

Surprising Muqarnas



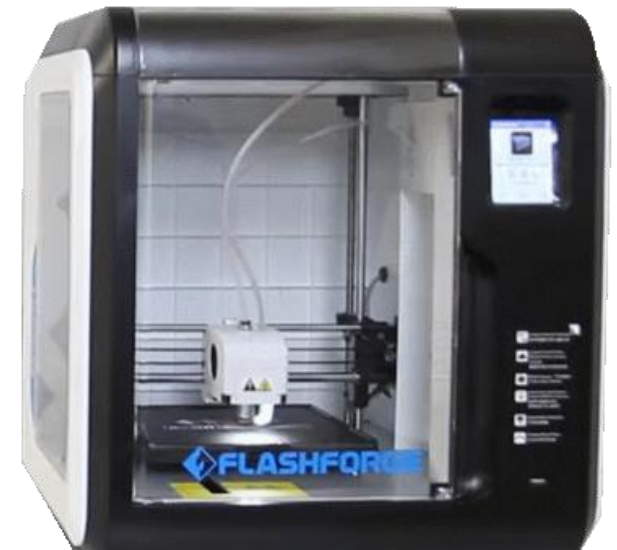
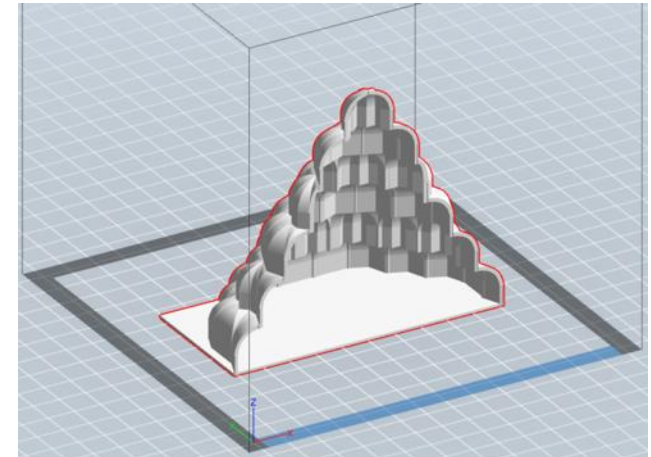
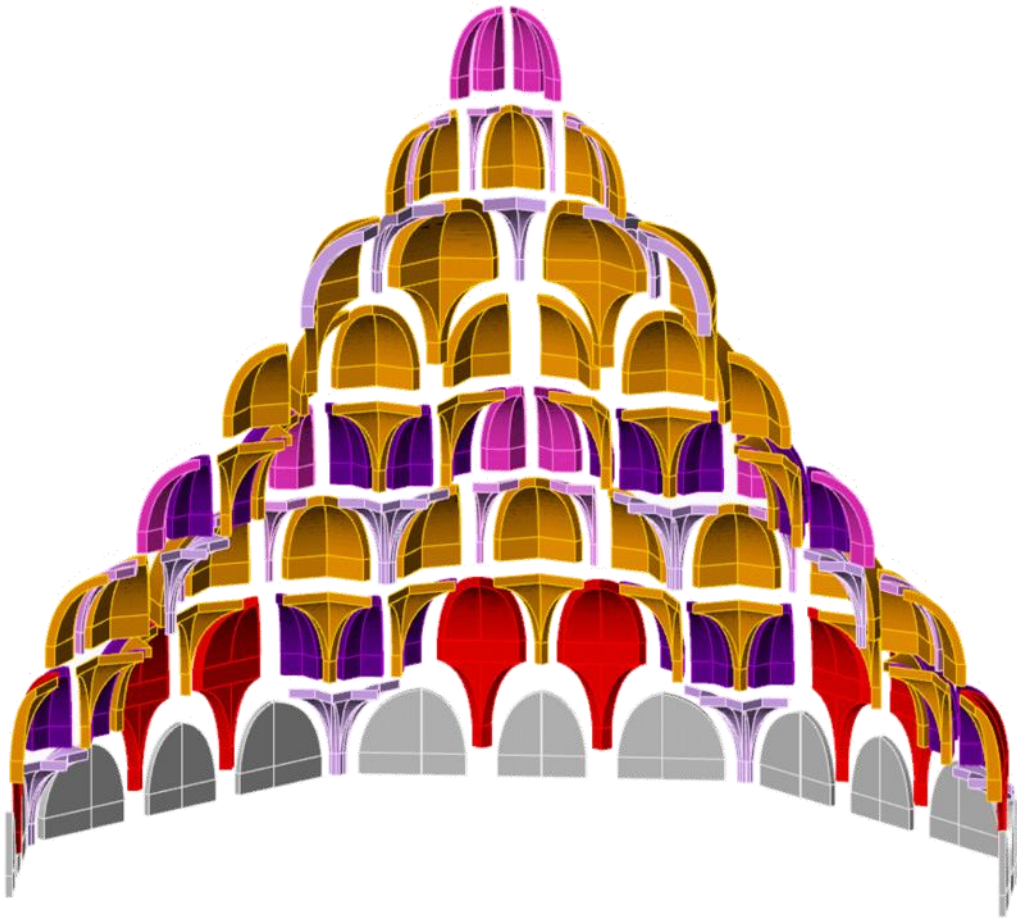
Welcome to St. Mary Church, Diyarbakır (a Syriac Orthodox church)



Welcome to Diyarbakır Behram Pasa (a Mimar Sinan mosque)



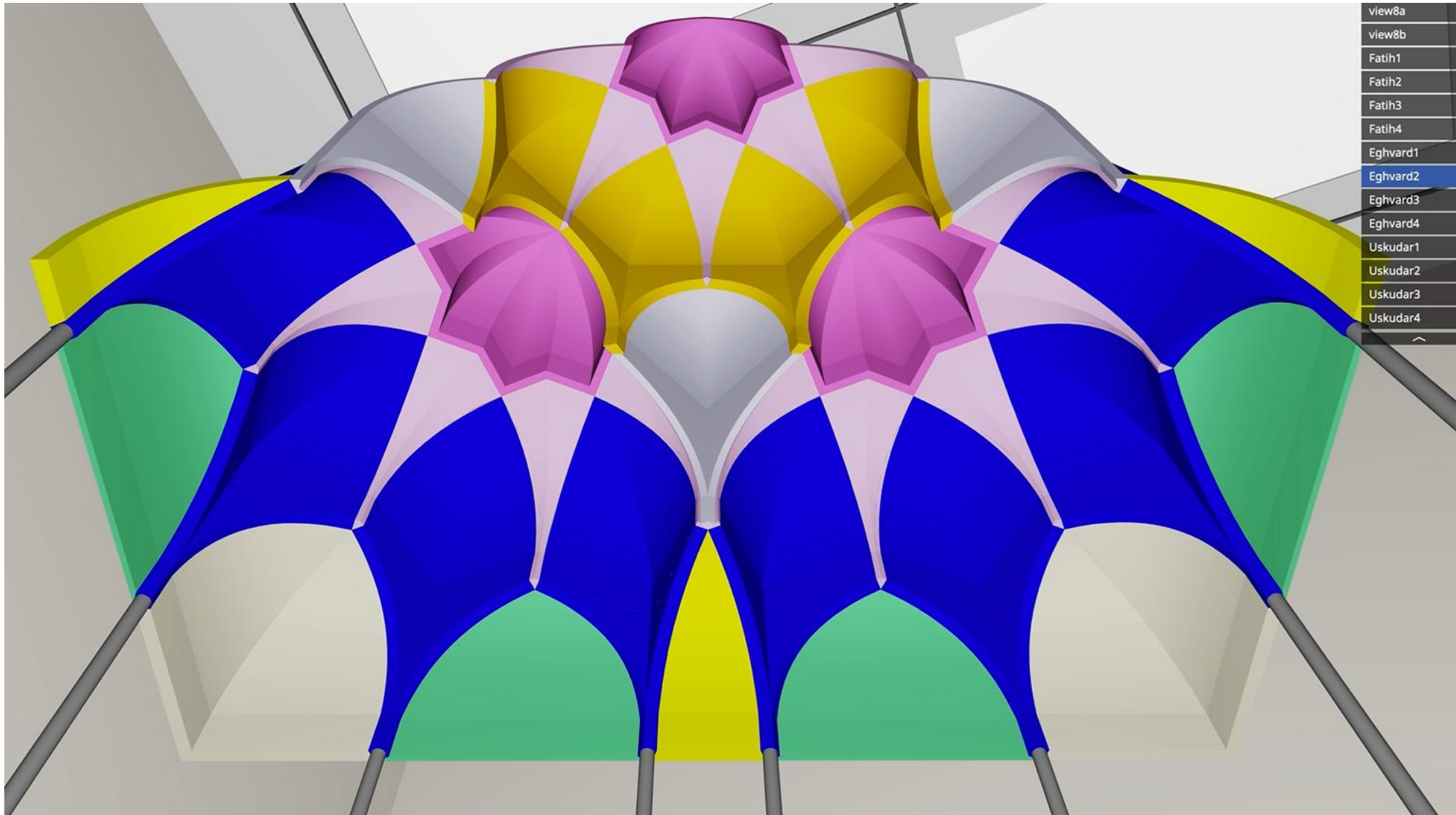
A visual interpreter



Click on a figure to open the corresponding webpage at www.henkietbrink.nl/muqarnas

Parametric Design in Rhino Grasshopper

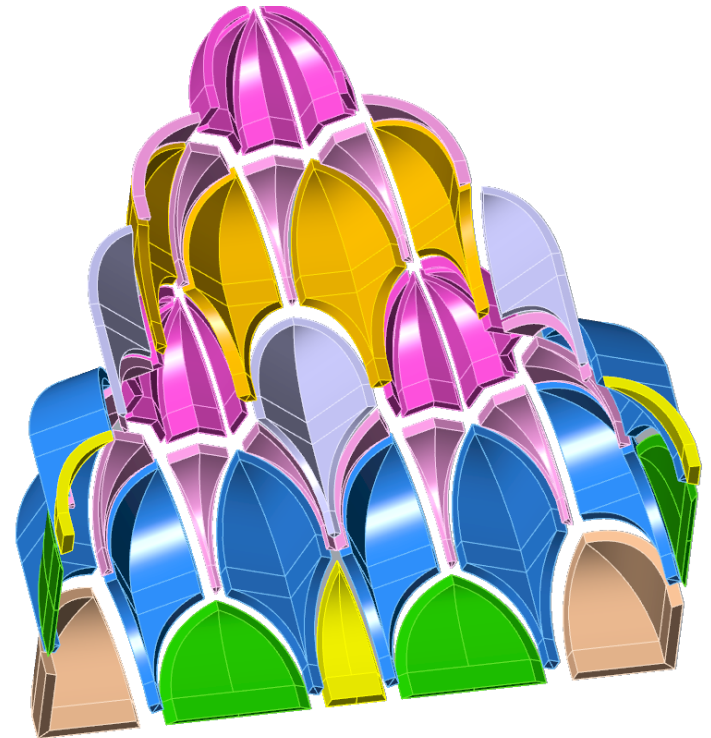
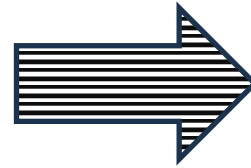
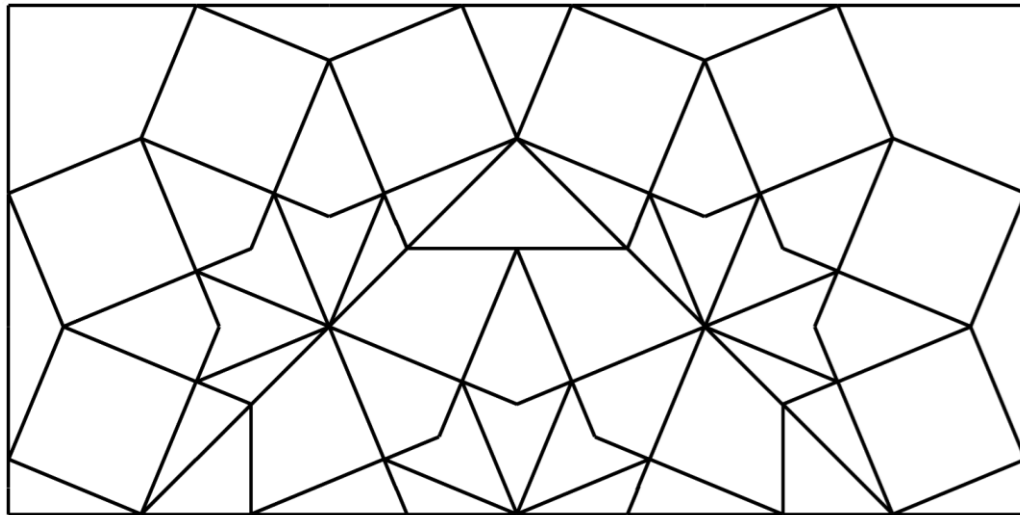
https://www.fransvanschooten.nl/muqarnas/museum_muqarnas.mov



Click on a figure to open the corresponding webpage at www.henkhetbrink.nl/muqarnas

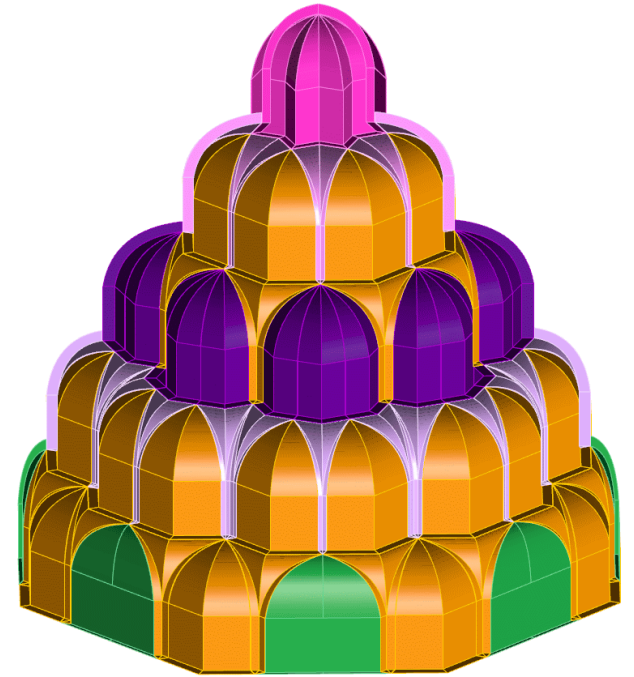
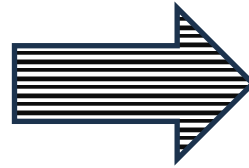
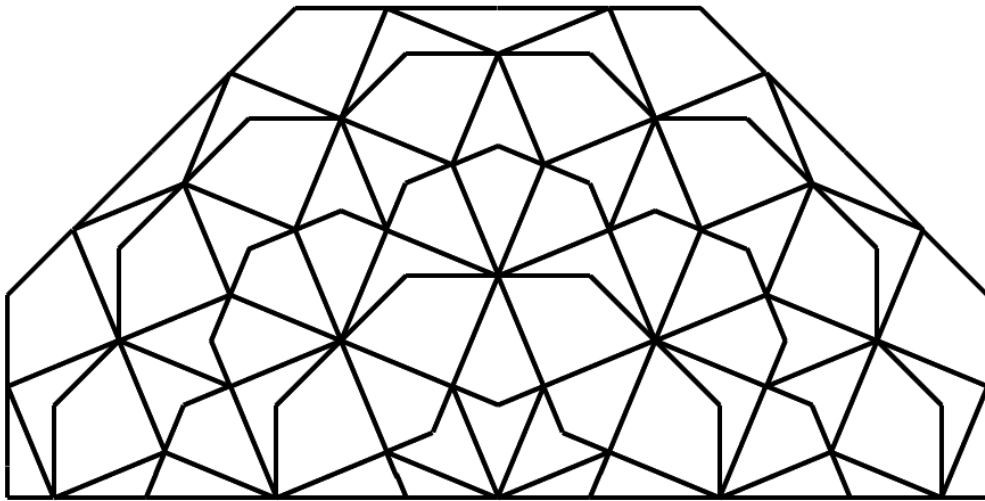
Understanding floor plans

**Can you elevate
a 2D tessellation plan
into 3D muqarnas ?**



Understanding muqarnas

**Can you elevate
a 2D tessellation plan
into 3D muqarnas ?**



Pre-defined Units

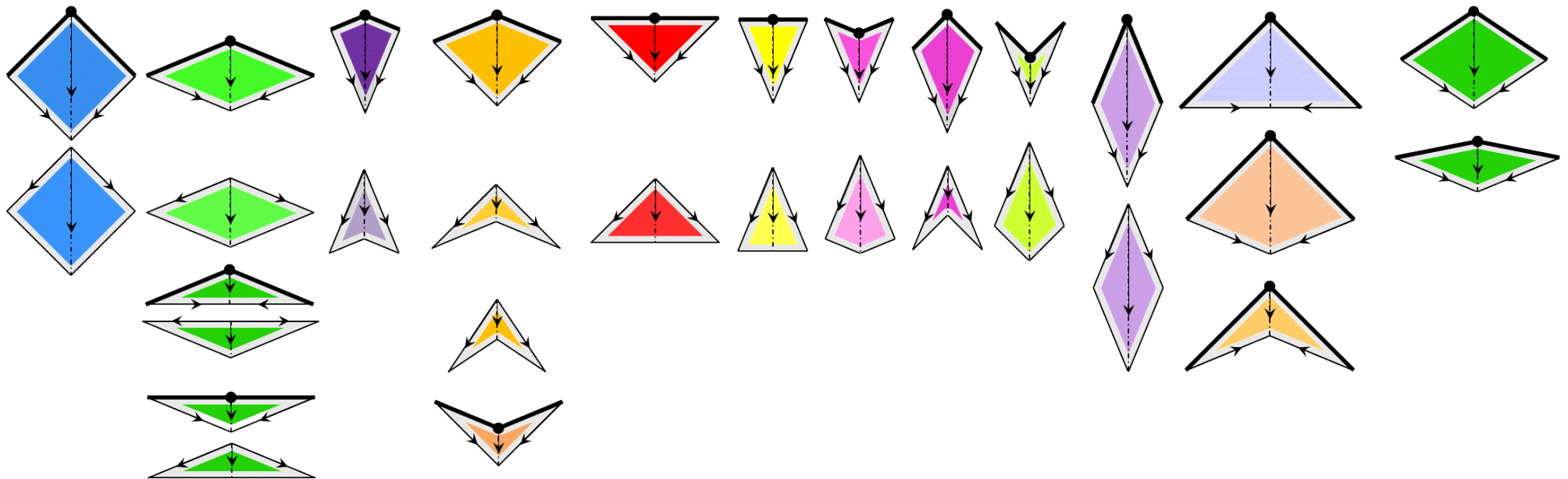


Table 1 of Pre defined Units

Is twelve enough, no we need M and N too

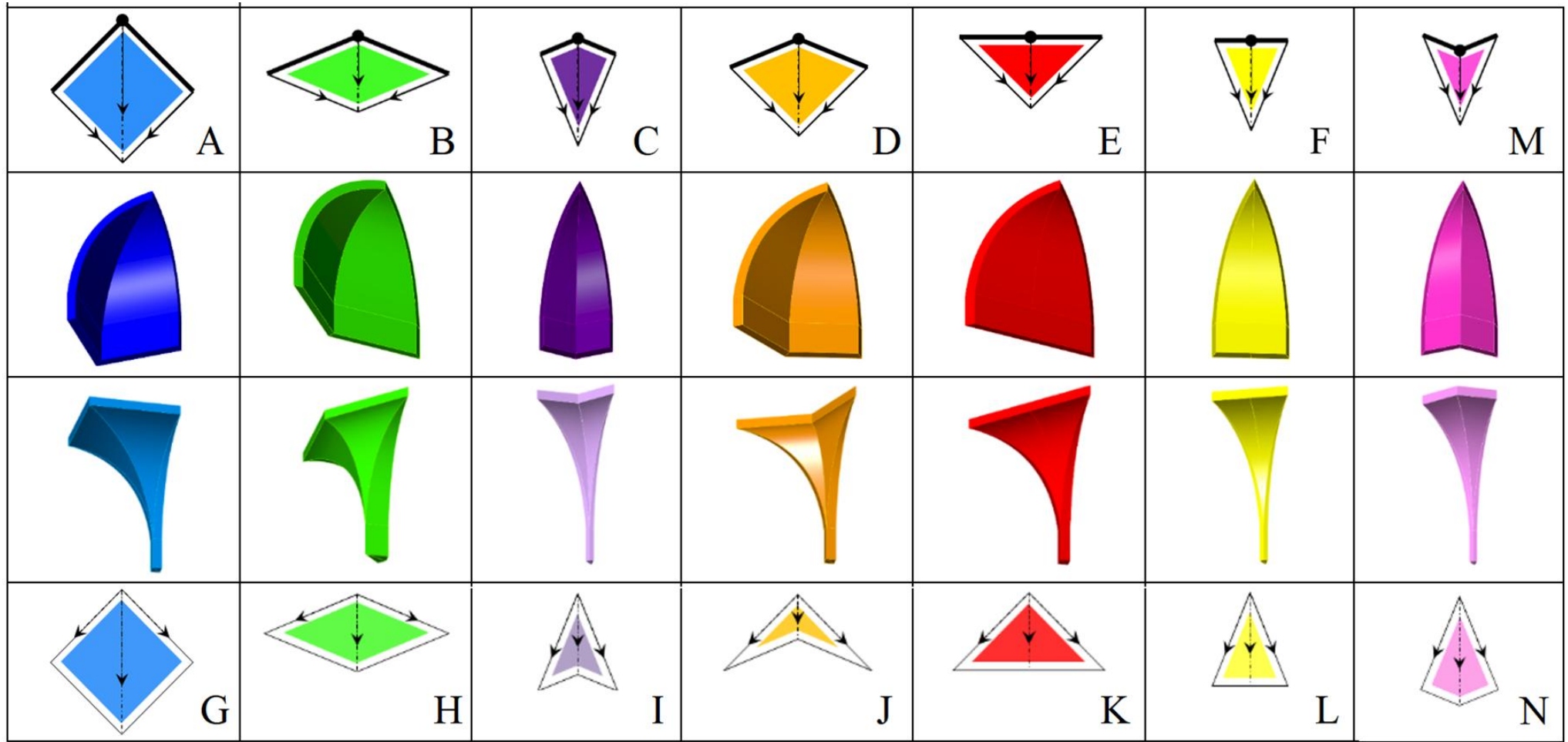


Table 2 of Pre defined Units

Write down all permutations

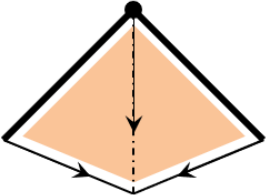
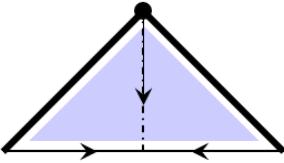
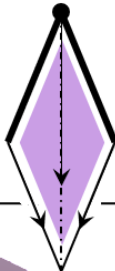
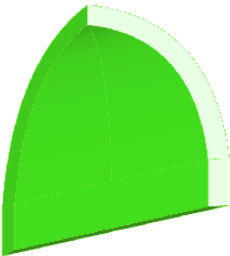
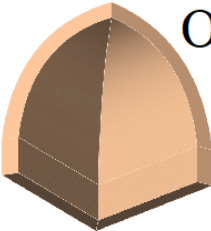
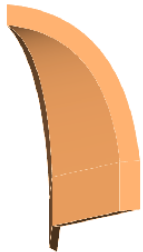
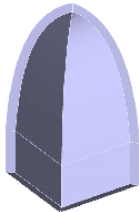
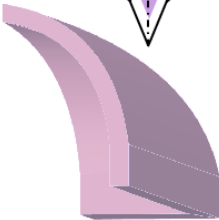
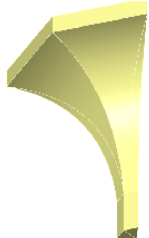
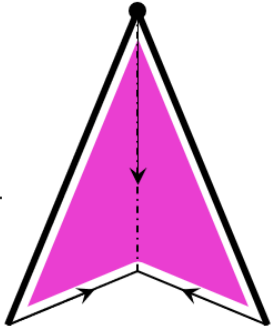
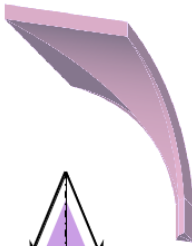
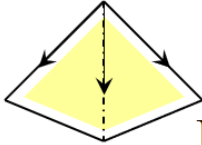
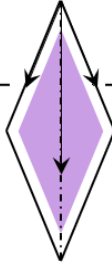
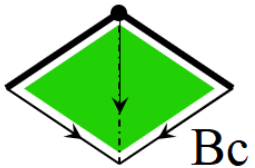
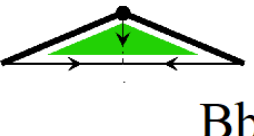
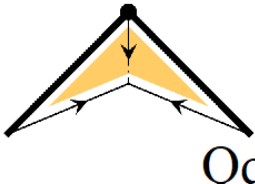
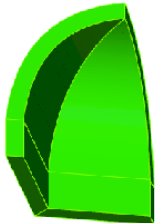
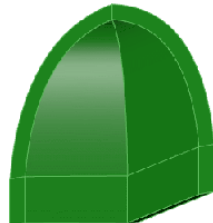
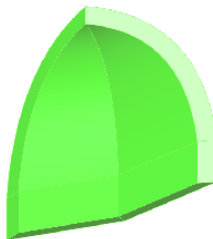
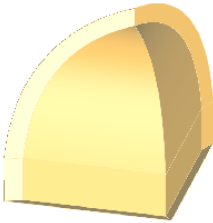
 Rr	 O	 Oo	 Q	 R	 T	 V
						
			 Qn			
 Ss	 Jj	 P		 S	 U	 W

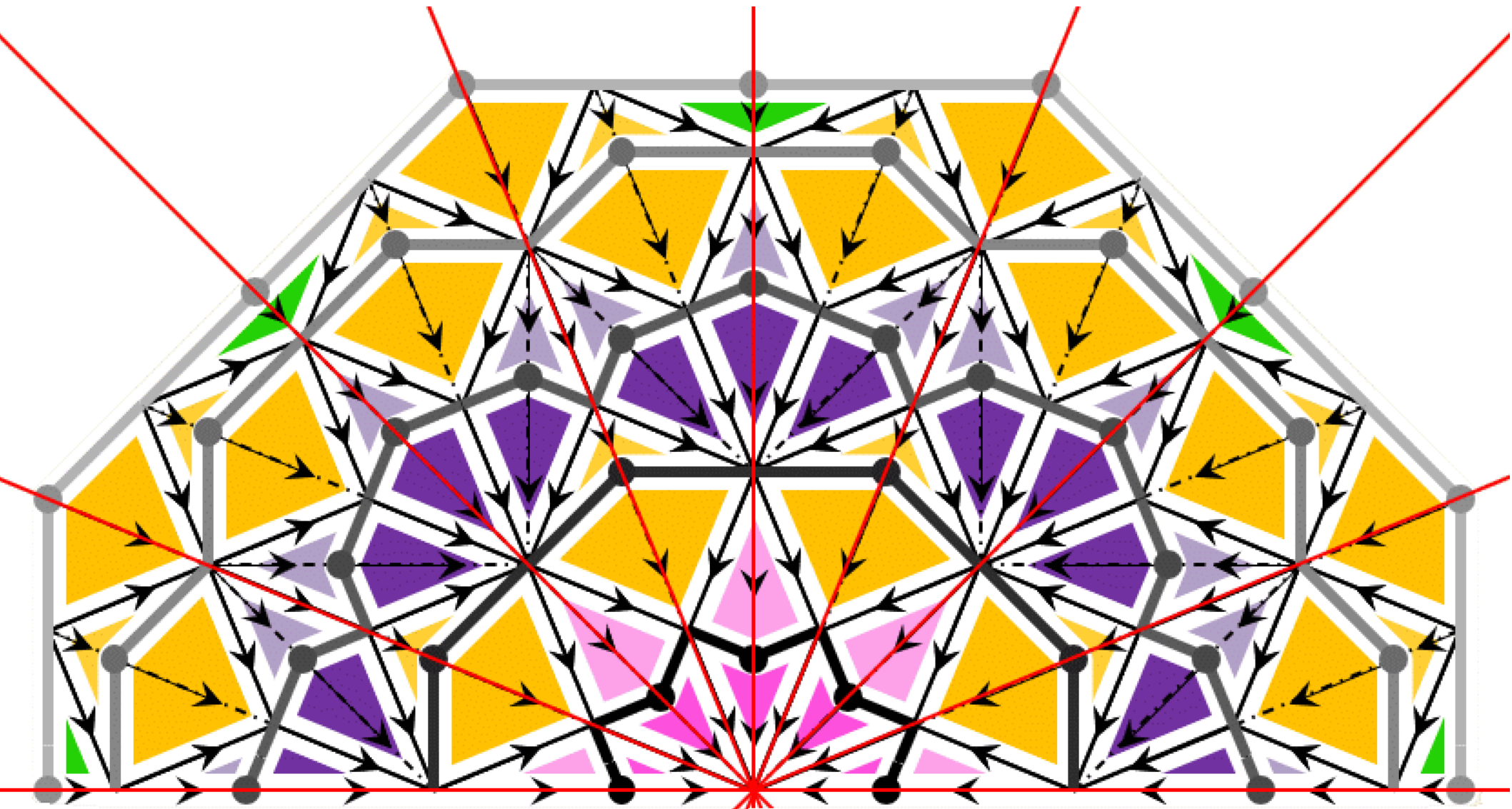
Table 3 of Pre defined Units

Parametric design: front angle, back angle

 Bc	 Bb	 Rb	 Qq			
						

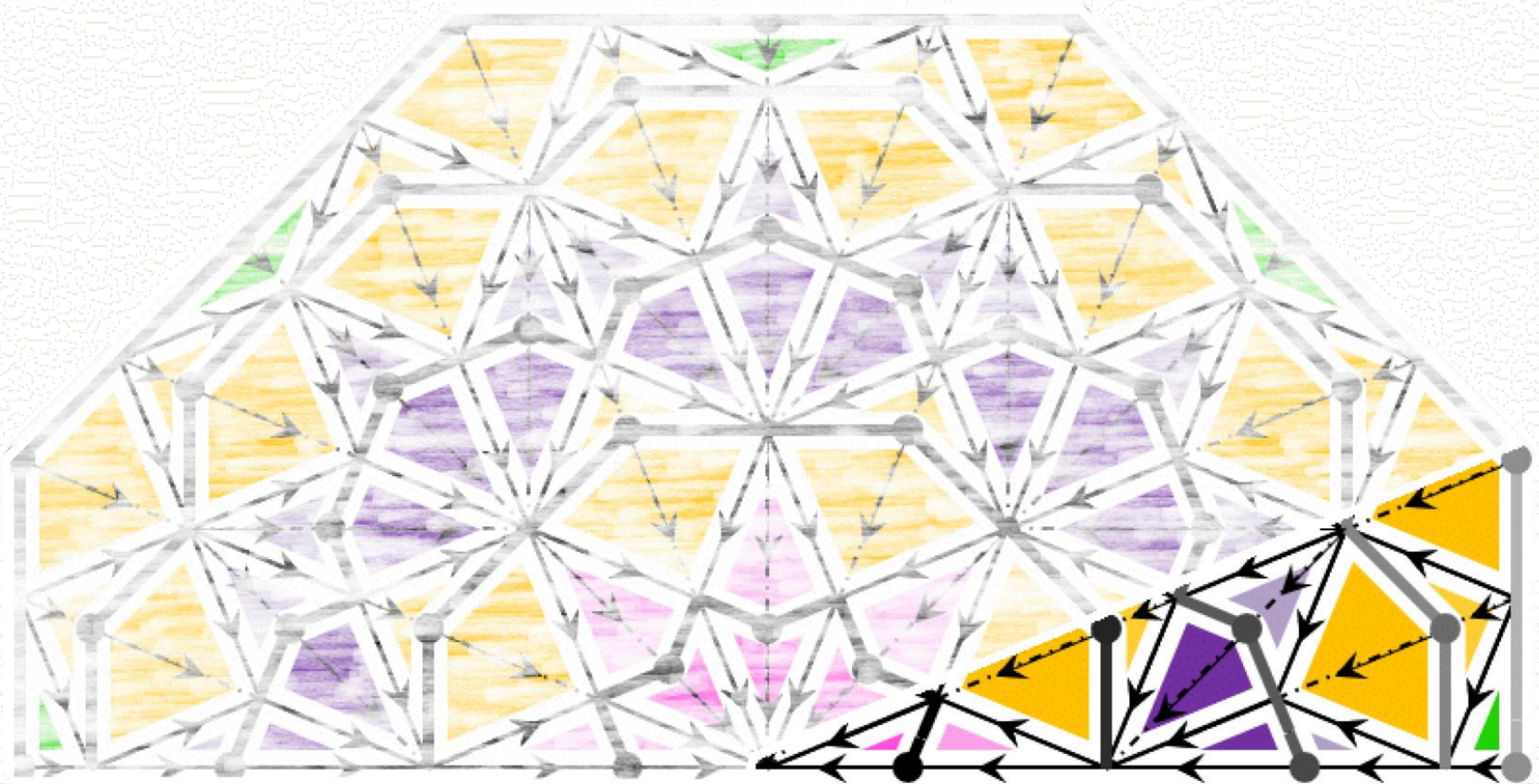
Example: Fatih, Istanbul

Muqarnas with a lot of symmetry



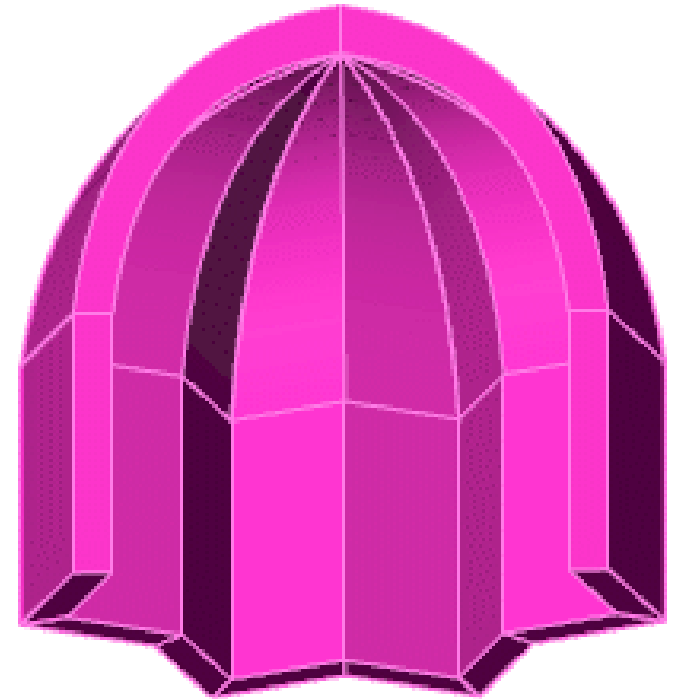
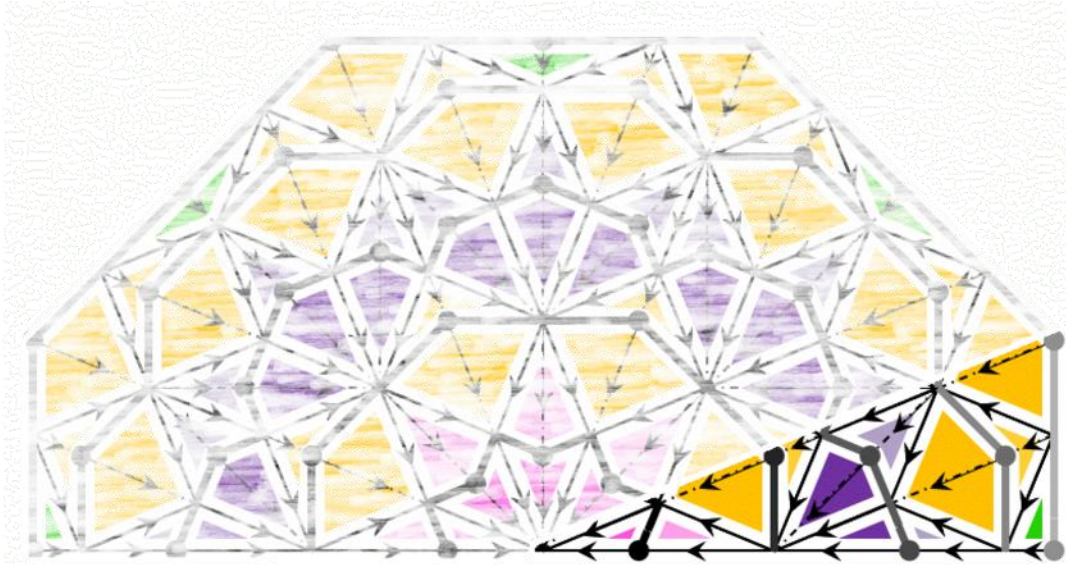
Click on a figure to open the corresponding webpage at www.henkietbrink.nl/muqarnas

Code single segment in Excel Interpreter does the reflection



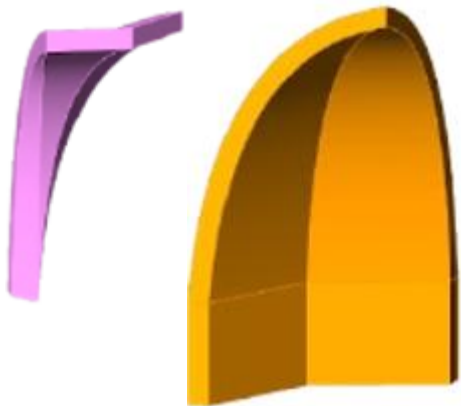
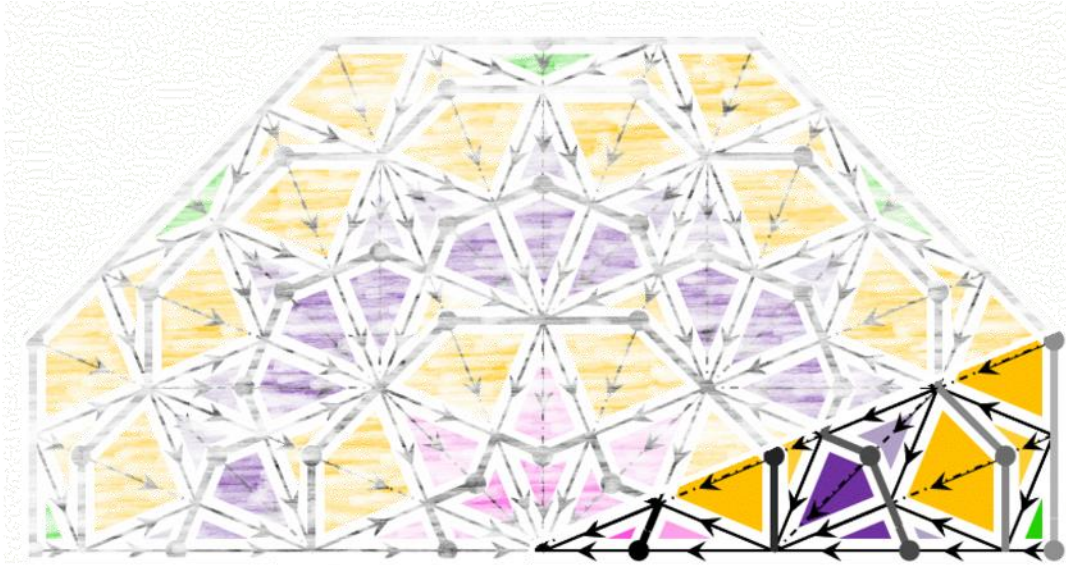
Click on a figure to open the corresponding webpage at www.henkhetbrink.nl/muqarnas

Step one: top layer pink M

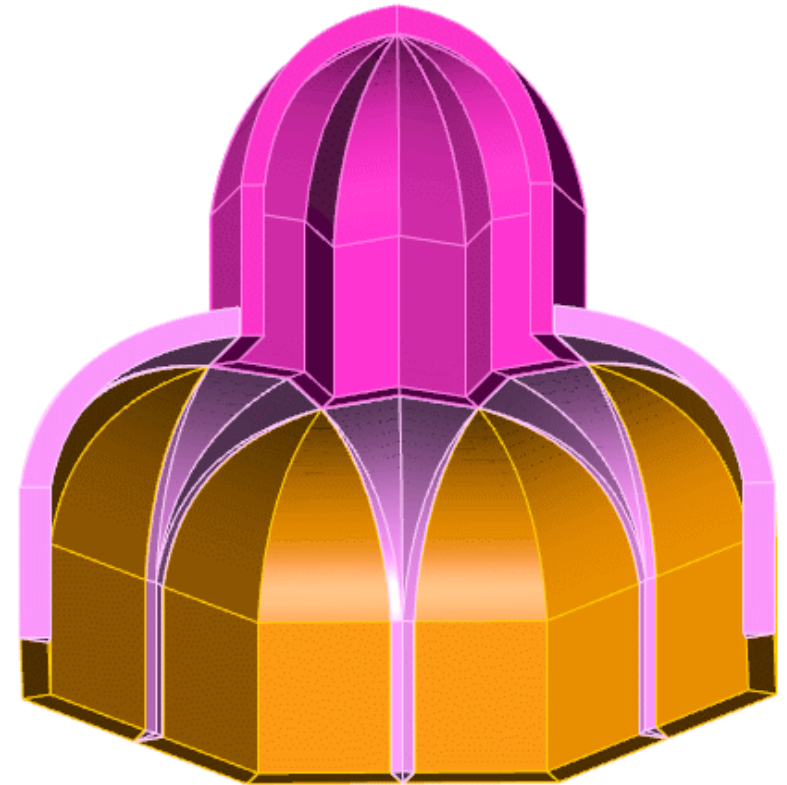


A	
1	Fatih Istanbul
4	M_left

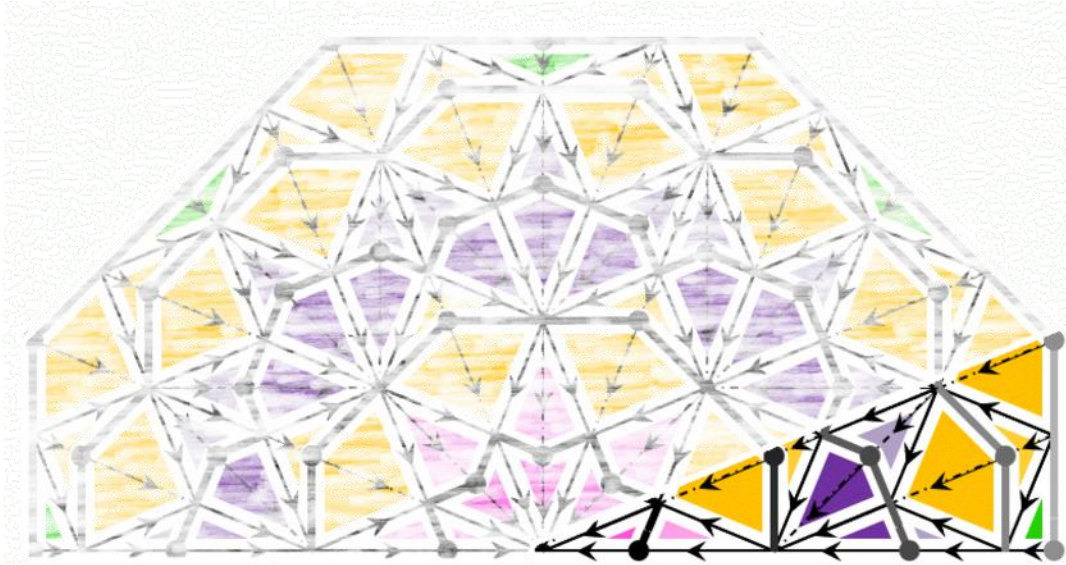
Step two: second layer from top pink N , orange D



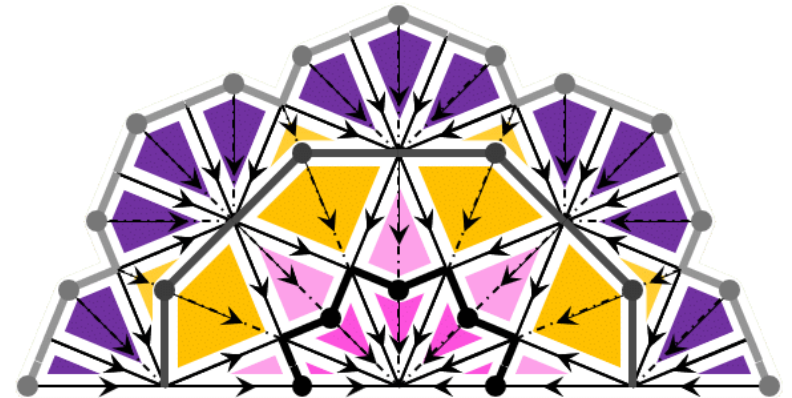
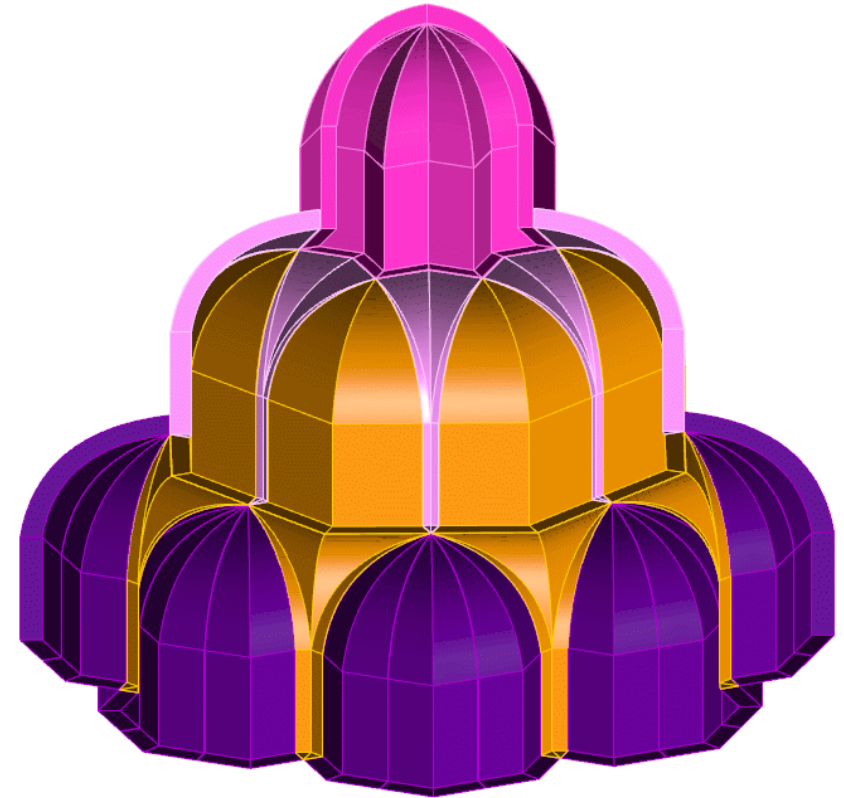
	A
1	Fatih Istanbul
4	M_left
5	N_left D_right



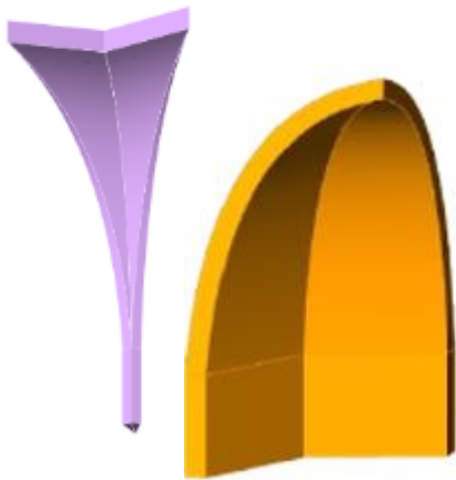
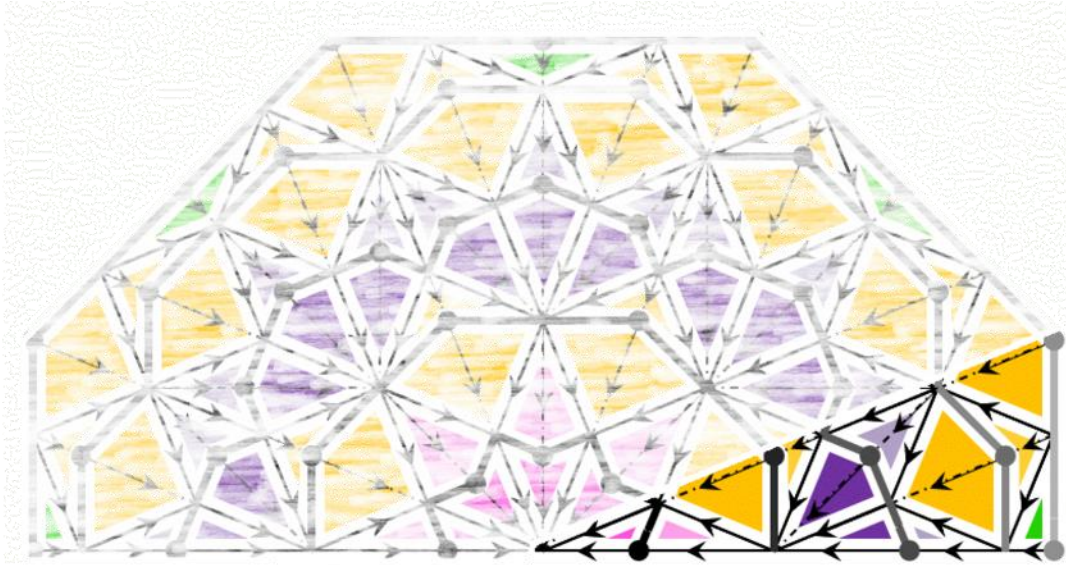
Step three: third layer from top purple C , orange J



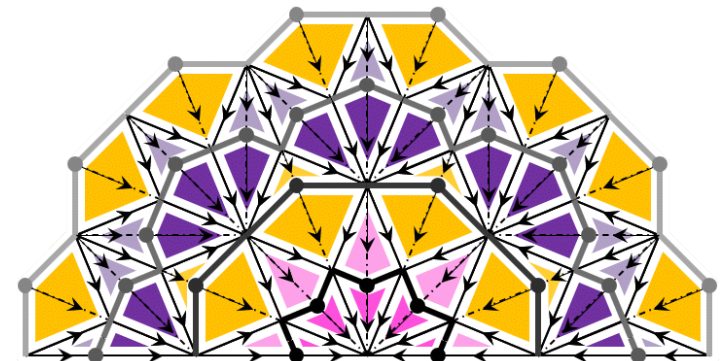
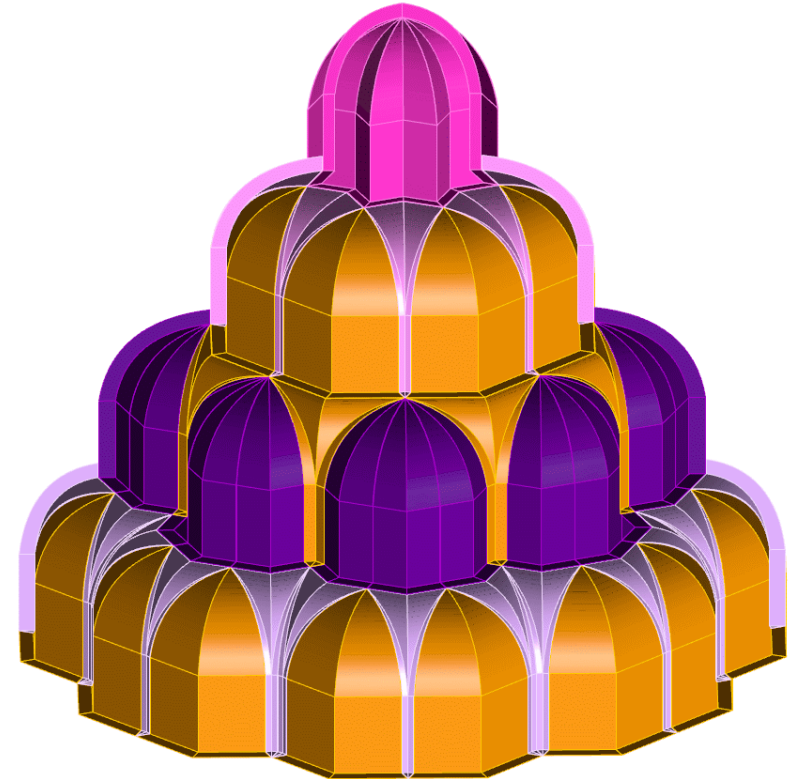
A	
1	Fatih Istanbul
4	M_left
5	N_left D_right
6	C_left C J_right



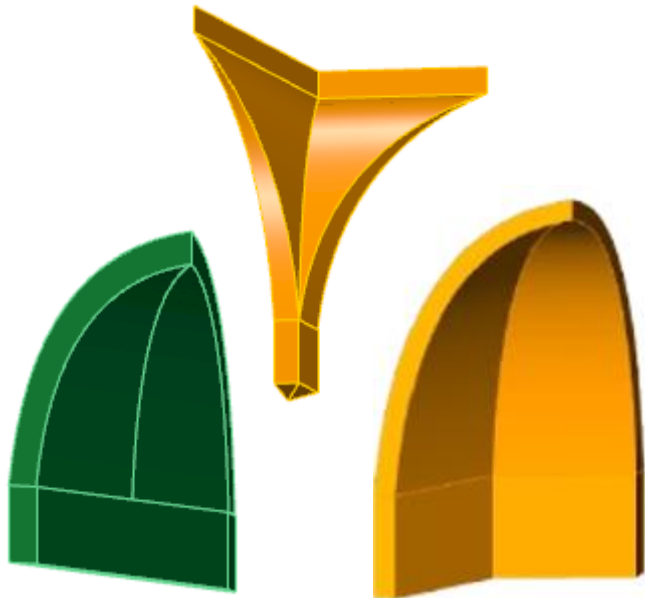
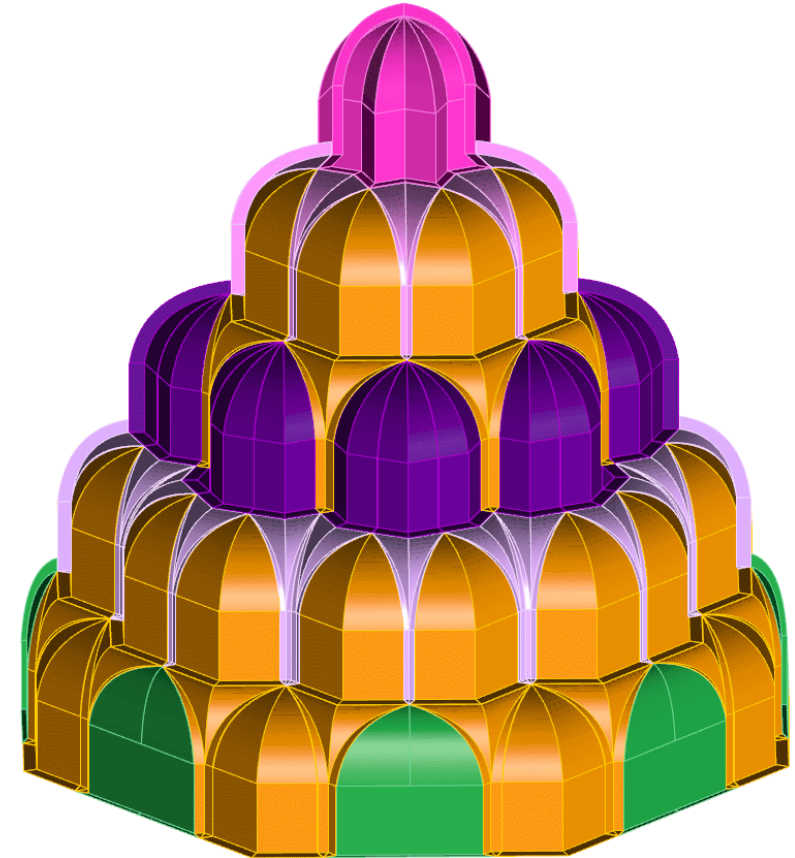
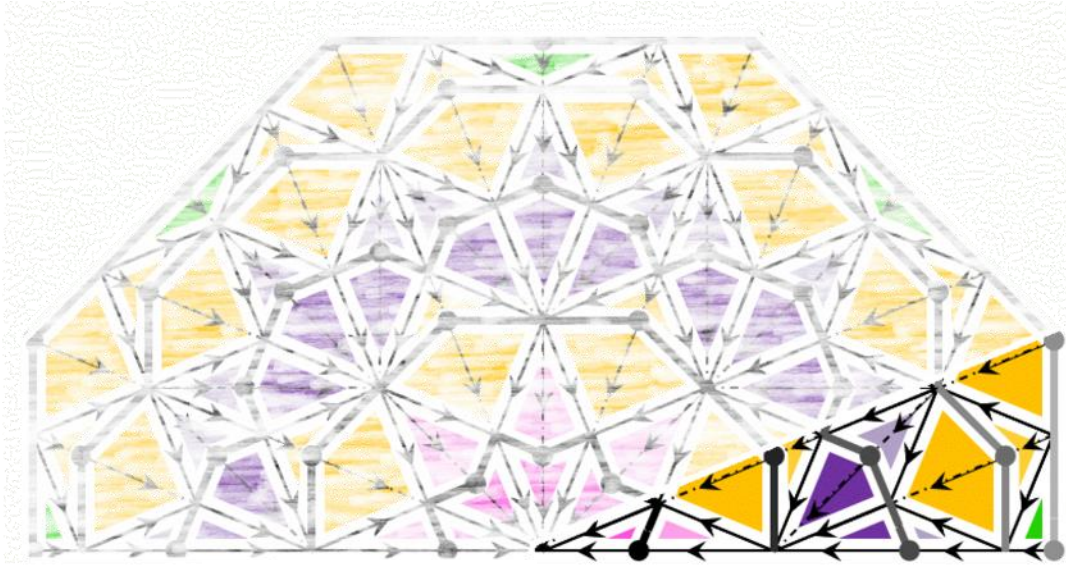
Step four: second layer from bottom purple I , orange D



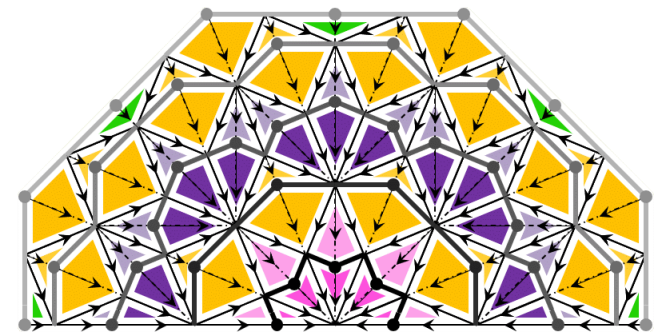
	A
1	Fatih Istanbul
4	M_left
5	N_left D_right
6	C_left C_right
7	I_left D I



Step five: third layer from top green Rr , orange J , orange D

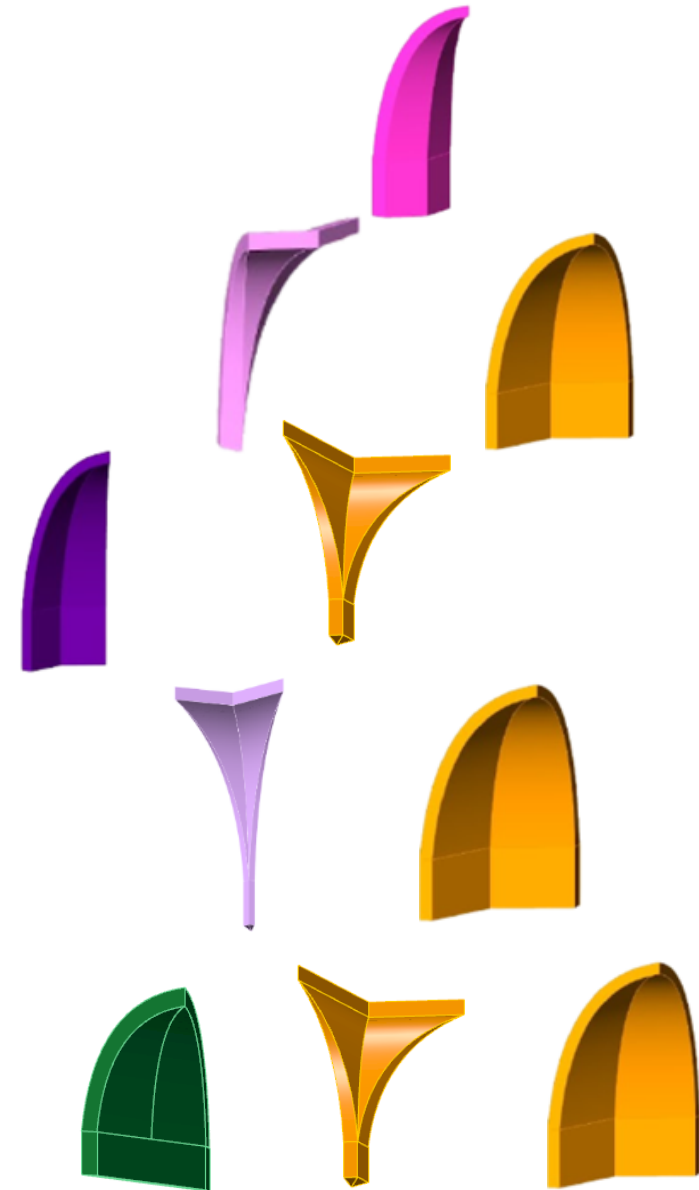


4	M_left
5	N_left D_right
6	C_left CJ_right
7	I_left D I
8	Rr_left J D_right

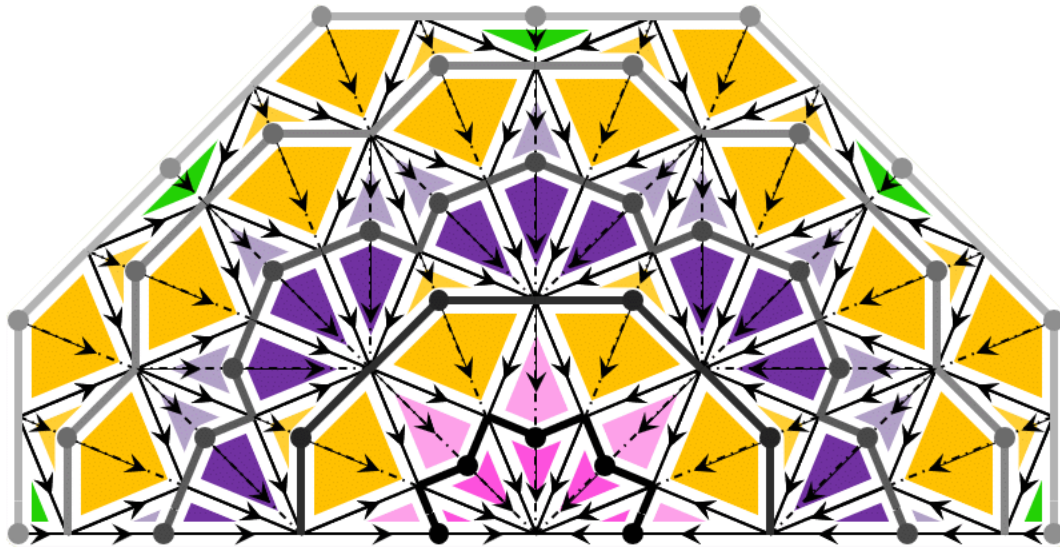


Input into Excel

4	M_left
5	N_left D_right
6	C_left C J_right
7	I_left D I
8	Rr_left J D_right



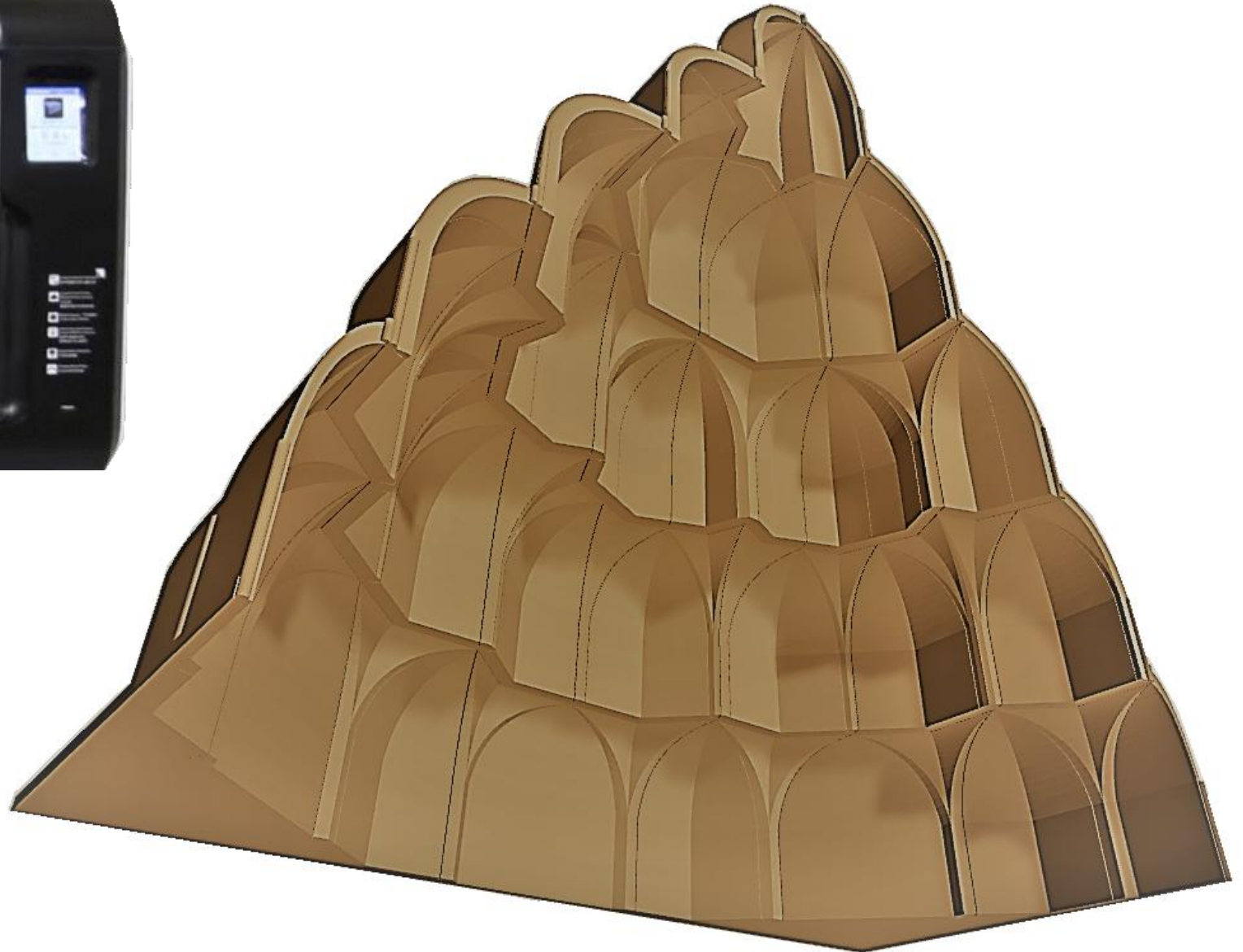
Output of Excel → 2D floorplan → CSV for Rhino/Grasshopper



```
1 Z2_{16-2};Z;Full;4.720777;0.809957;0;0.35;1.4;180;2;0.707107;0.35;1.05;0;0;16;Diyarbakir Melek Ahmet
2 Z1_{16-3};Z;Full;4.720777;0.809957;0;0.35;1.4;180;1;1;0.35;1.05;0;0;16;
3 I_{16-5};I;Intermediate;4.720777;1.95541;0;0.35;1.4;-202.5;0;1.145452;0.35;1.05;0;0;16;
4 I_{16-6};I;Intermediate;4.720777;1.95541;0;0.35;1.4;-247.5;0;1.145452;0.35;1.05;0;0;16;
5 I_{16-7};I;Intermediate;4.720777;1.95541;0;0.35;1.4;-292.5;0;1.145452;0.35;1.05;0;0;16;
6 Z2_{16-9};Z;Full;3.910819;2.765367;0;0.35;1.4;-135;2;1;0.35;1.05;0;0;16;
7 Z1_{16-10};Z;Full;3.910819;2.765367;0;0.35;1.4;-135;1;0.707107;0.35;1.05;0;0;16;
8 Z2_{16-11};Z;Full;2.765367;3.910819;0;0.35;1.4;-135;2;0.707107;0.35;1.05;0;0;16;
9 Z1_{16-12};Z;Full;2.765367;3.910819;0;0.35;1.4;-135;1;1;0.35;1.05;0;0;16;
10 I_{16-14};I;Intermediate;1.95541;4.720777;0;0.35;1.4;-157.5;0;1.145452;0.35;1.05;0;0;16;
11 I_{16-15};I;Intermediate;1.95541;4.720777;0;0.35;1.4;-202.5;0;1.145452;0.35;1.05;0;0;16;
12 I_{16-16};I;Intermediate;1.95541;4.720777;0;0.35;1.4;-247.5;0;1.145452;0.35;1.05;0;0;16;
13 Z2_{16-18};Z;Full;0.809957;4.720777;0;0.35;1.4;-90;2;1;0.35;1.05;0;0;16;
14 Z1_{16-19};Z;Full;0.809957;4.720777;0;0.35;1.4;-90;1;0.707107;0.35;1.05;0;0;16;
15 Z2_{16-20};Z;Full;-0.809957;4.720777;0;0.35;1.4;-90;2;0.707107;0.35;1.05;0;0;16;
16 Z1_{16-21};Z;Full;-0.809957;4.720777;0;0.35;1.4;-90;1;1;0.35;1.05;0;0;16;
17 I_{16-23};I;Intermediate;-1.95541;4.720777;0;0.35;1.4;-112.5;0;1.145452;0.35;1.05;0;0;16;
18 I_{16-24};I;Intermediate;-1.95541;4.720777;0;0.35;1.4;-157.5;0;1.145452;0.35;1.05;0;0;16;
19 I_{16-25};I;Intermediate;-1.95541;4.720777;0;0.35;1.4;-202.5;0;1.145452;0.35;1.05;0;0;16;
20 Z2_{16-27};Z;Full;-2.765367;3.910819;0;0.35;1.4;-45;2;1;0.35;1.05;0;0;16;
21 Z1_{16-28};Z;Full;-2.765367;3.910819;0;0.35;1.4;-45;1;0.707107;0.35;1.05;0;0;16;
22 Z2_{16-29};Z;Full;-3.910819;2.765367;0;0.35;1.4;-45;2;0.707107;0.35;1.05;0;0;16;
23 Z1_{16-30};Z;Full;-3.910819;2.765367;0;0.35;1.4;-45;1;1;0.35;1.05;0;0;16;
24 I_{16-32};I;Intermediate;-4.720777;1.95541;0;0.35;1.4;-67.5;0;1.145452;0.35;1.05;0;0;16;
25 I_{16-33};I;Intermediate;-4.720777;1.95541;0;0.35;1.4;-112.5;0;1.145452;0.35;1.05;0;0;16;
26 I_{16-34};I;Intermediate;-4.720777;1.95541;0;0.35;1.4;-157.5;0;1.145452;0.35;1.05;0;0;16;
27 Z2_{16-36};Z;Full;-4.720777;0.809957;0;0.35;1.4;0;2;1;0.35;1.05;0;0;16;
28 Z1_{16-37};Z;Full;-4.720777;0.809957;0;0.35;1.4;0;1;0.707107;0.35;1.05;0;0;16;
29 E_{15-0};E;Full;4.720777;0;1.4;1.75;2.8;292.5;1;1.145452;0.35;1.05;-1.4;15;
30 C_{15-1};C;Full;4.385281;1.145452;1.4;1.75;2.8;337.5;0;1.145452;0.35;1.05;0;0;15;
31 J_{15-2};J;Intermediate;3.910819;1.145452;1.4;1.75;2.8;135;0;1.145452;0.35;1.05;0;0;15;
32 C_{15-3};C;Full;3.910819;1.619914;1.4;1.75;2.8;292.5;0;1.145452;0.35;1.05;0;0;15;
33 J_{15-4};J;Intermediate;3.575324;1.95541;1.4;1.75;2.8;90;0;1.145452;0.35;1.05;0;0;15;
34 C_{15-5};C;Full;3.910819;2.290905;1.4;1.75;2.8;247.5;0;1.145452;0.35;1.05;0;0;15;
35 E_{15-6};E;Full;3.338093;3.338093;1.4;1.75;2.8;315;0;1.145452;0.35;1.05;-1.4;15;
36 C_{15-7};C;Full;2.290905;3.910819;1.4;1.75;2.8;22.5;0;1.145452;0.35;1.05;0;0;15;
37 J_{15-8};J;Intermediate;1.95541;3.575324;1.4;1.75;2.8;180;0;1.145452;0.35;1.05;0;0;15;
38 C_{15-9};C;Full;1.619914;3.910819;1.4;1.75;2.8;337.5;0;1.145452;0.35;1.05;0;0;15;
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40 C_{15-11};C;Full;1.145452;4.385281;1.4;1.75;2.8;292.5;0;1.145452;0.35;1.05;0;0;15;
41 E_{15-12};E;Full;0;4.720777;1.4;1.75;2.8;0;0;1.145452;0.35;1.05;-1.4;15;
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43 J_{15-14};J;Intermediate;-1.145452;3.910819;1.4;1.75;2.8;-135;0;1.145452;0.35;1.05;0;0;15;
44 C_{15-15};C;Full;-1.619914;3.910819;1.4;1.75;2.8;22.5;0;1.145452;0.35;1.05;0;0;15;
45 J_{15-16};J;Intermediate;-1.95541;3.575324;1.4;1.75;2.8;-180;0;1.145452;0.35;1.05;0;0;15;
46 C_{15-17};C;Full;-2.290905;3.910819;1.4;1.75;2.8;-22.5;0;1.145452;0.35;1.05;0;0;15;
47 E_{15-18};E;Full;-3.338093;3.338093;1.4;1.75;2.8;45;0;1.145452;0.35;1.05;-1.4;15;
48 C_{15-19};C;Full;-3.910819;2.290905;1.4;1.75;2.8;112.5;0;1.145452;0.35;1.05;0;0;15;
49 J_{15-20};J;Intermediate;-3.575324;1.95541;1.4;1.75;2.8;-90;0;1.145452;0.35;1.05;0;0;15;
50 C_{15-21};C;Full;-3.910819;1.619914;1.4;1.75;2.8;67.5;0;1.145452;0.35;1.05;0;0;15;
```

Rhino Grasshopper

→ STL file → 3D printer



Agenda

- **Try to identify the tiers and allocate the units accordingly.**
 - Be aware that you can find unacceptable alternatives
- **Rare units**
- **Multiple solutions**
- **Incorrect drawings**
- **Size matters**
- **Non-monotony**
- **Pentagons in an octagonal grid**
- **Flat panels cause problems in graph theory**
- **Püskül (tassels) and other ornaments**
- **Encourage you to read Turkish literature**

On Tour

- **Marmara University Theology Faculty Mosque**
- **Takht-i Sulayman Southern Octagon**
- **Takht-i Sulayman Central Dome**
- **Diyarbakır Kasim Padisah**
- **Mardin Kasim Padisah**
- **Mardin Sultan Isa Medresesi**
- **Diyarbakır Iskender Pasa**
- **Kayseri Sultan Han**
- **Afyon Tas Medrese**
- **Bursa Muradiye Complex**
- **Istanbul Üsküdar Atik Valide**

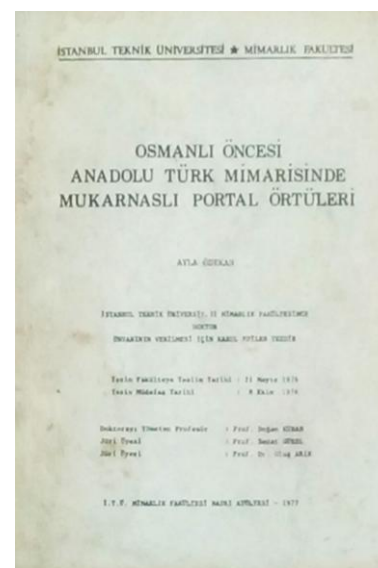
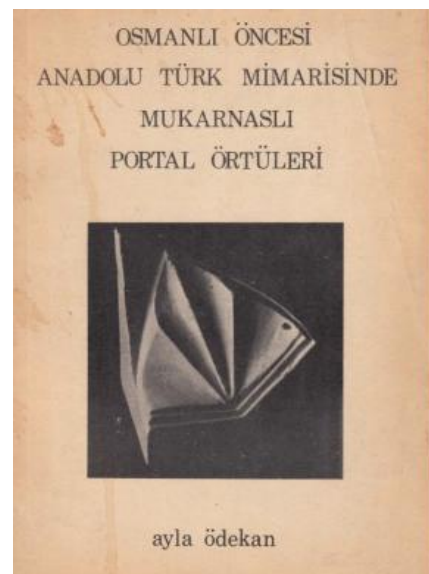
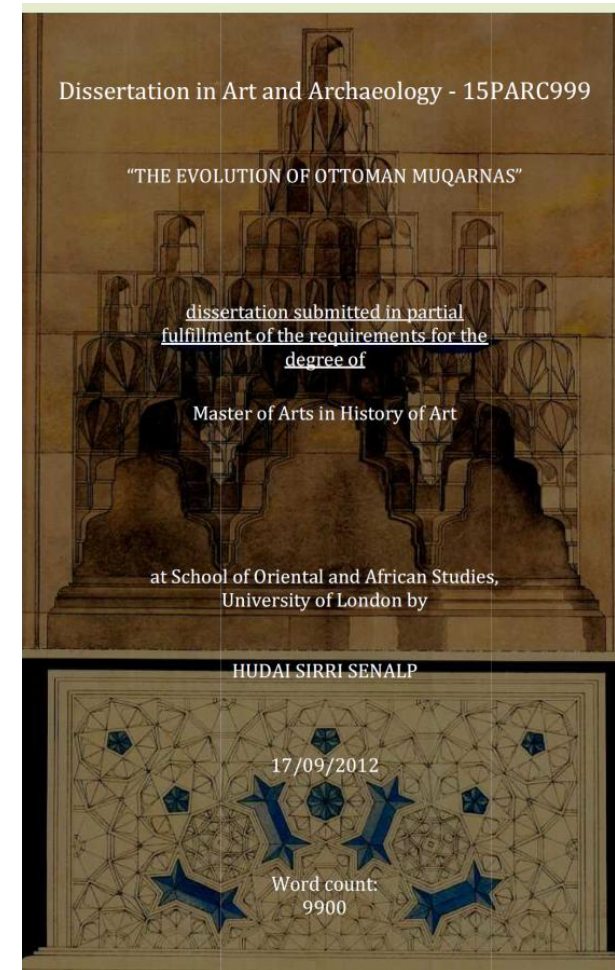
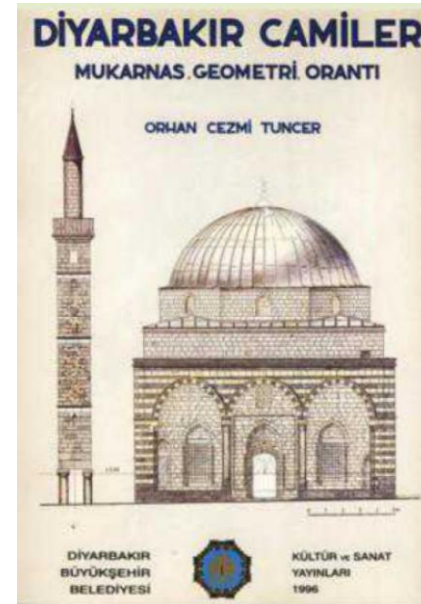
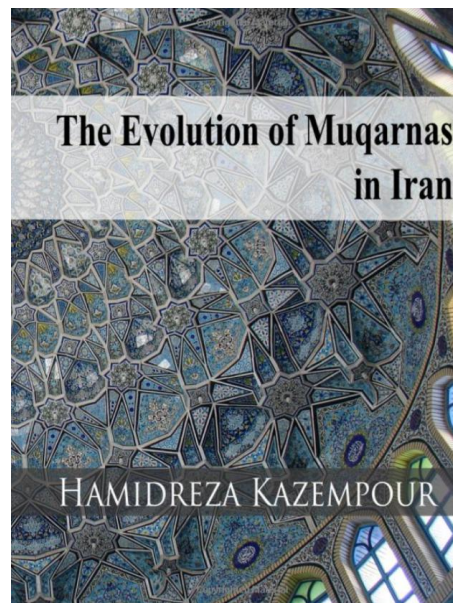
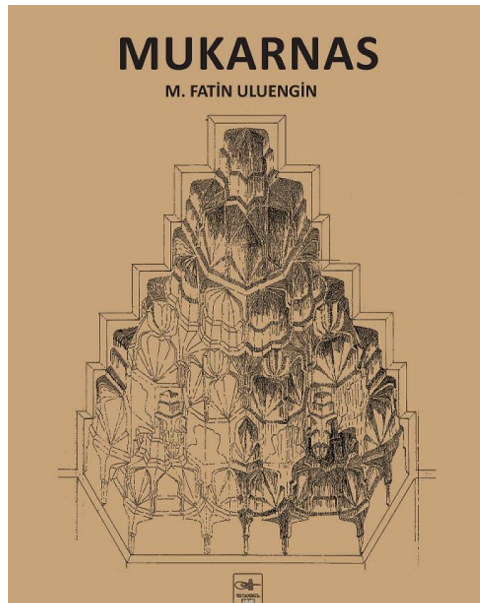
Conclusion

- **Muqarnas are complex ornaments**
 - Huge variety
 - Exceptional constructions
 - It's art, architecture, not mathematics
 - Family tradition
- **Parametric software is a powerful tool**
 - 2D and 3D
 - Engineers use Rhino
- **3D animations are essential**
 - to find correct interpretation of floor plans

Solution to understand muqarnas

- **Go there, stay there**
 - Visit all the places
 - Both the touristic hotspots and the unknown places
- **Desk research is essential**
 - but even better is measuring the muqarnas on site
- **Talk to local architects and engineers**
- **Learn Turkish: read books and papers**
 - Lot of literature
 - PhD thesis, for example Senalp

Study muqarnas: read a book



Translation Support

Sorry for mentioning your competitors.

No worries at all! It actually makes your presentation feel honest and practical. You're pointing people to useful tools—including me. No offense taken. 😊

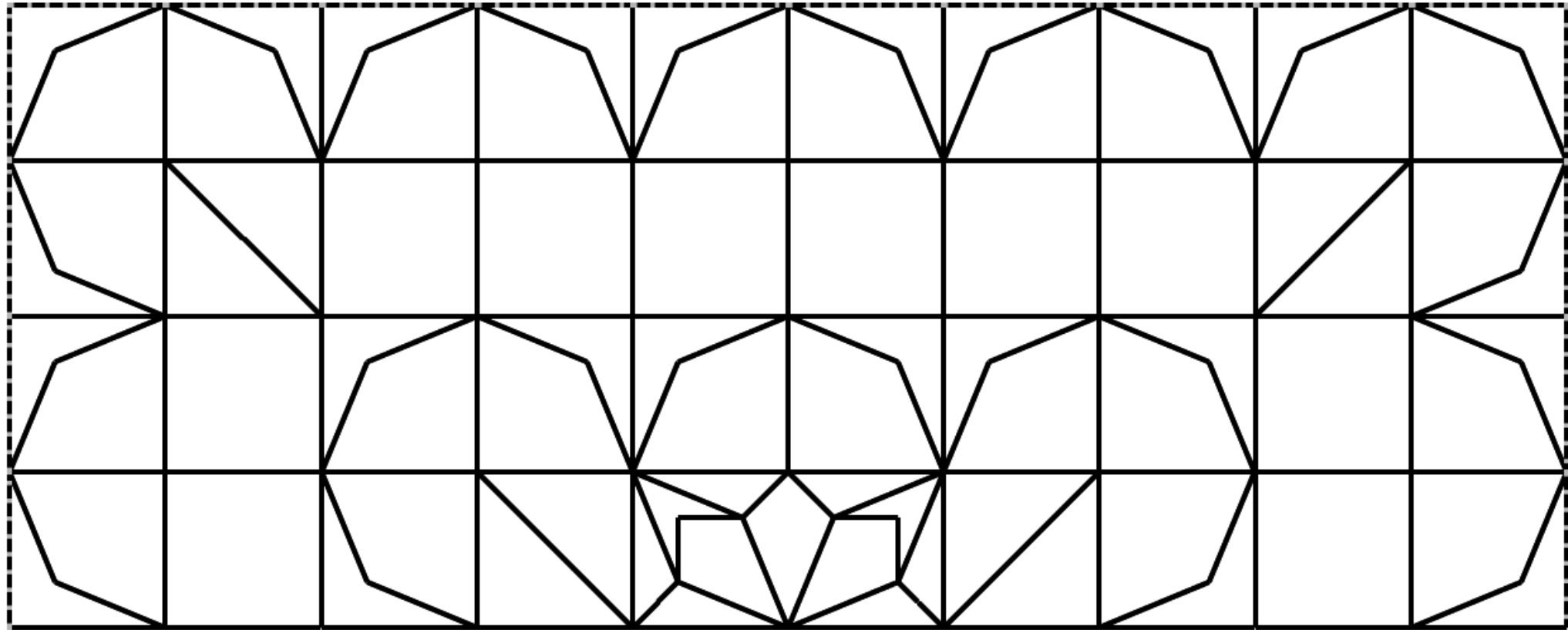
Tour starts now

- **Marmara University Theology Faculty Mosque**
- **Takht-i Sulayman Southern Octagon**
- **Takht-i Sulayman Central Dome**
- **Diyarbakır Kasim Padisah**
- **Mardin Kasim Padisah**
- **Mardin Sultan Isa Medresesi**
- **Diyarbakır Iskender Pasa**
- **Kayseri Sultan Han**
- **Afyon Tas Medrese**
- **Bursa Muradiye Complex**
- **Istanbul Üsküdar Atik Valide**

Istanbul Üsküdar Marmara University Theology Faculty Mosque

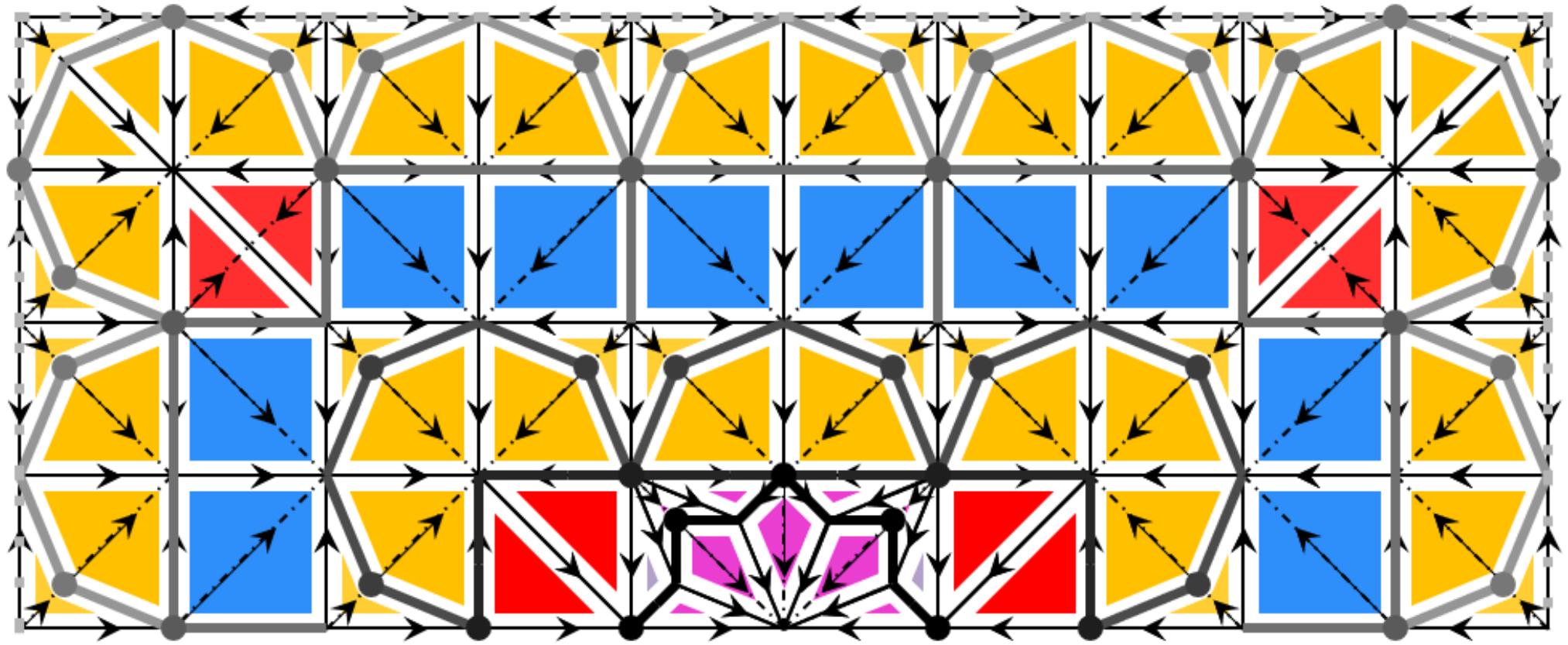


Find the tiers and assign the units



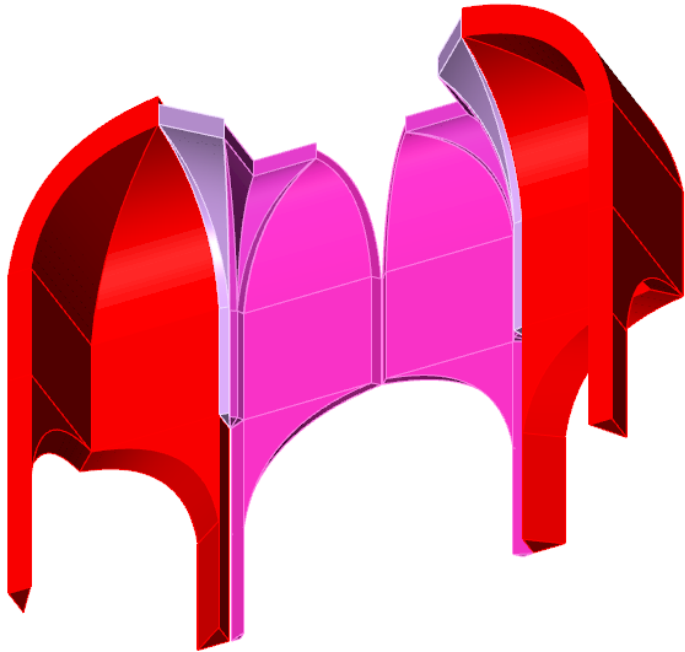
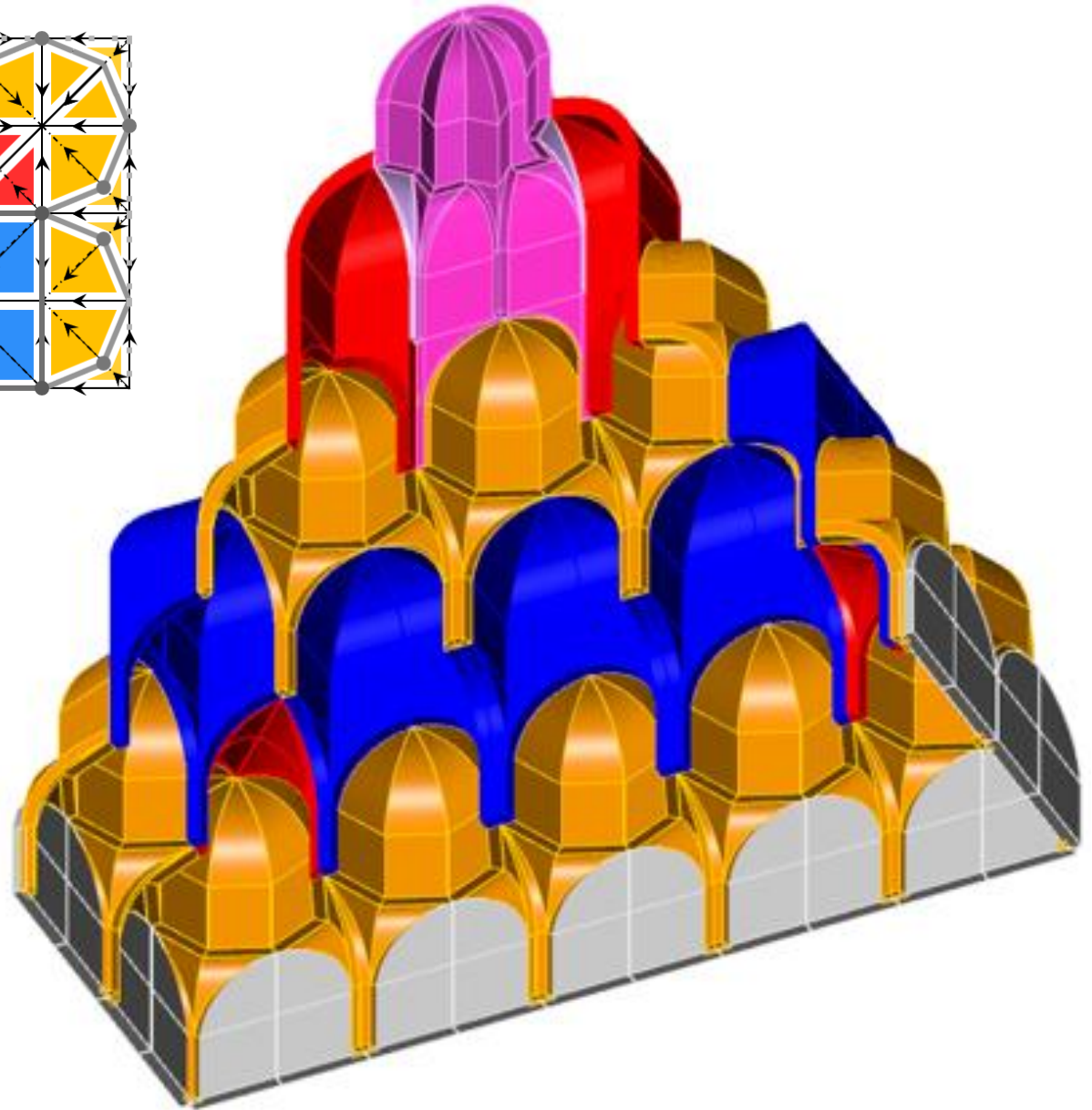
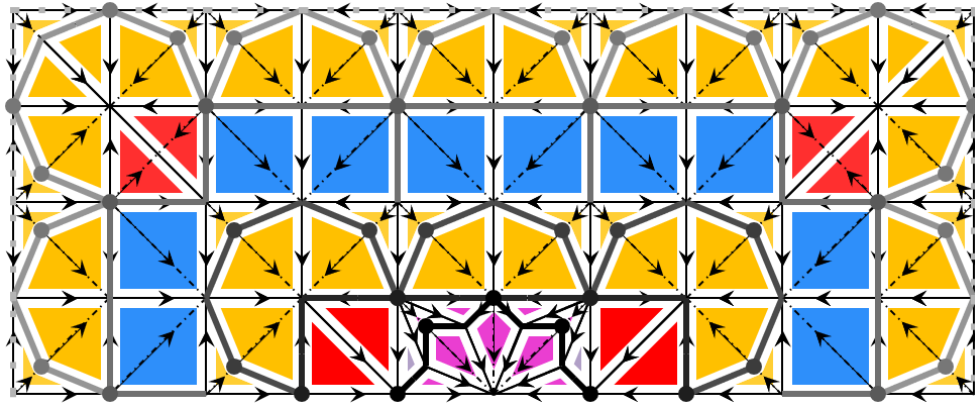
Quest for new pre-defined units

Systematic approach of all configurations



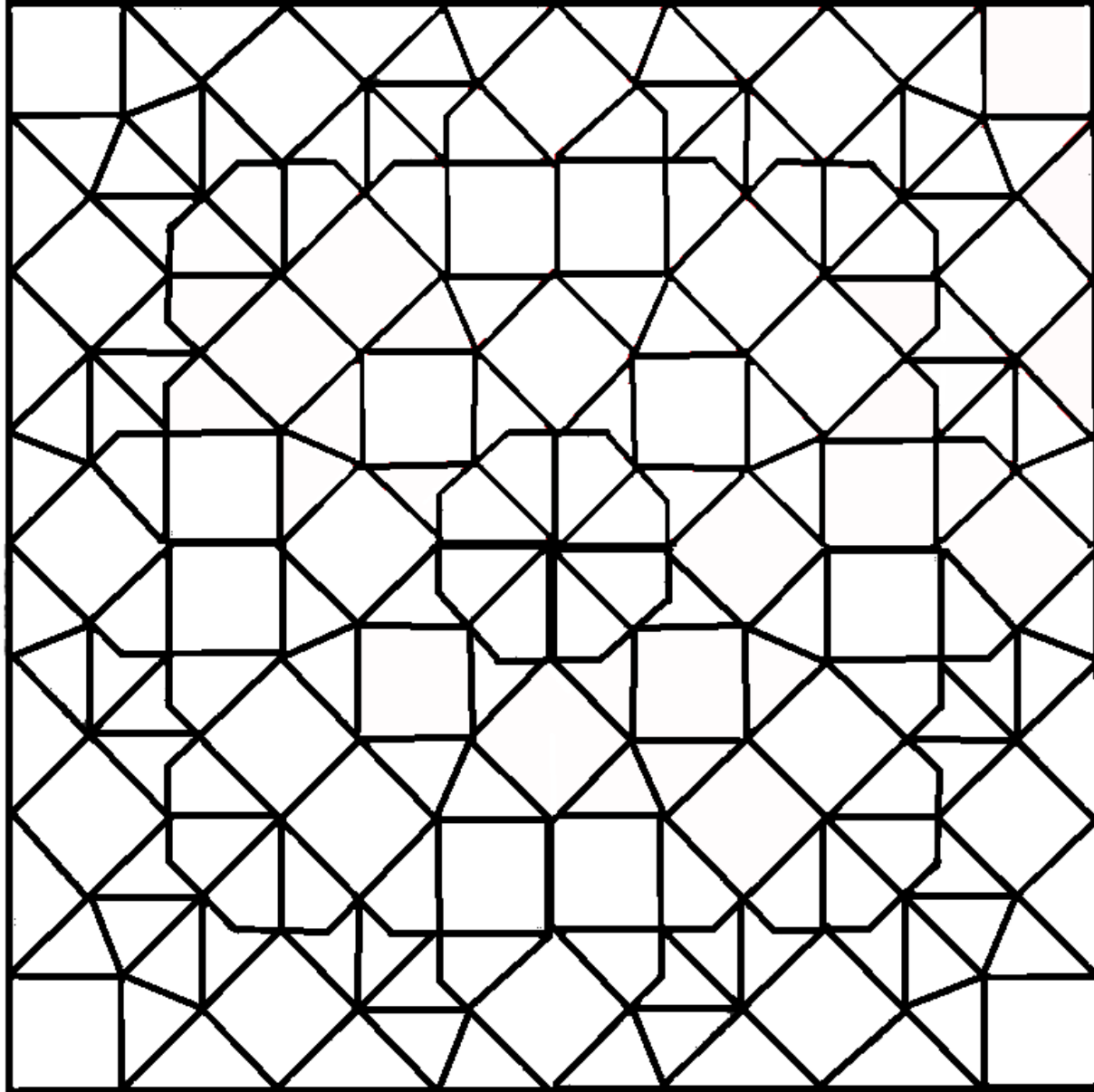
Quest for new pre-defined units

Systematic approach of all configurations

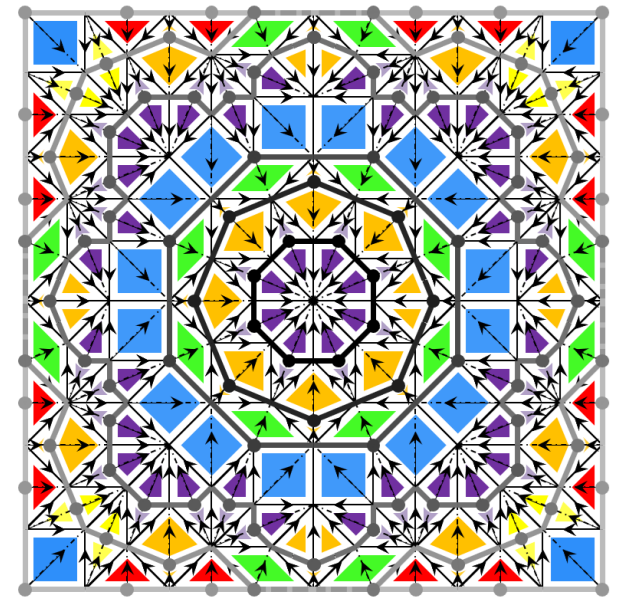
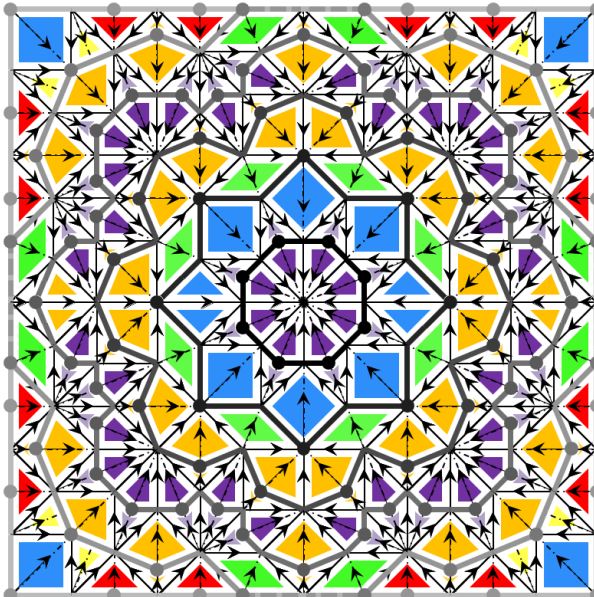
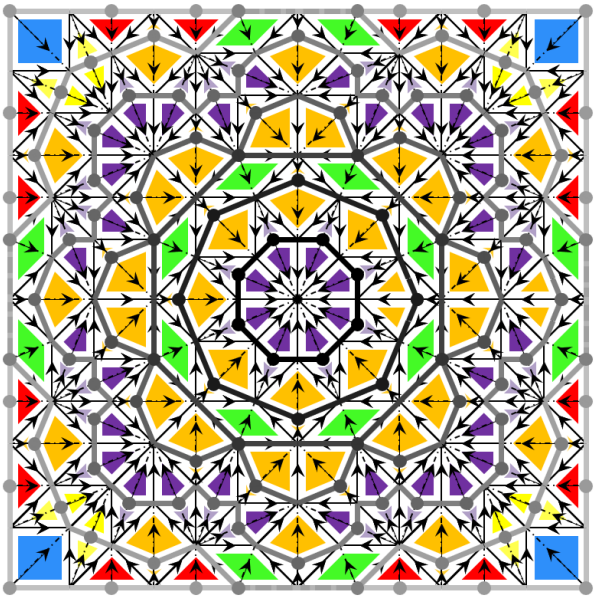
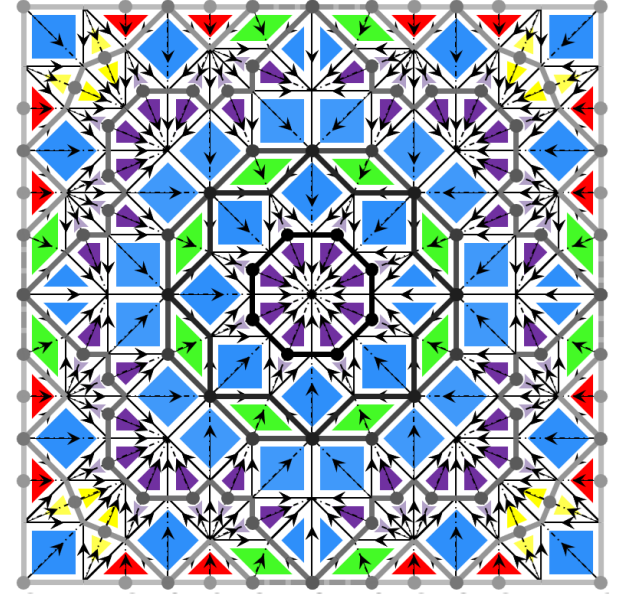
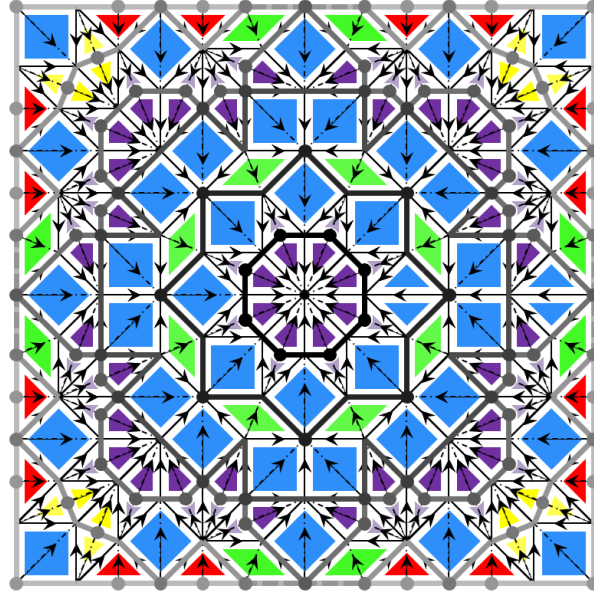
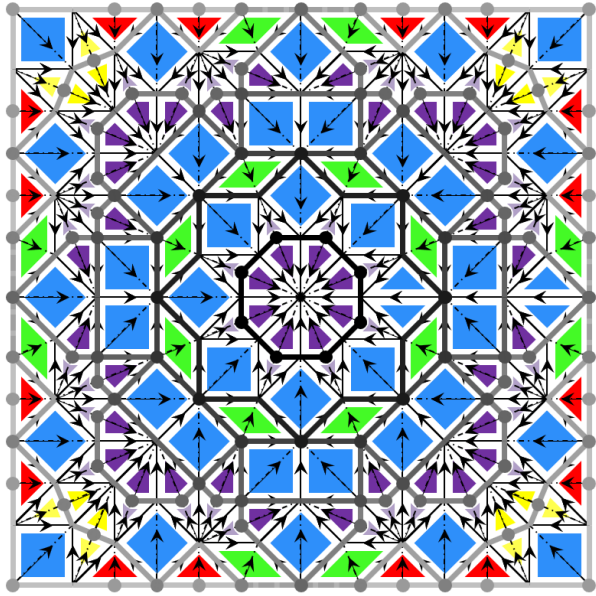


How to elevate this design from 2D to 3D

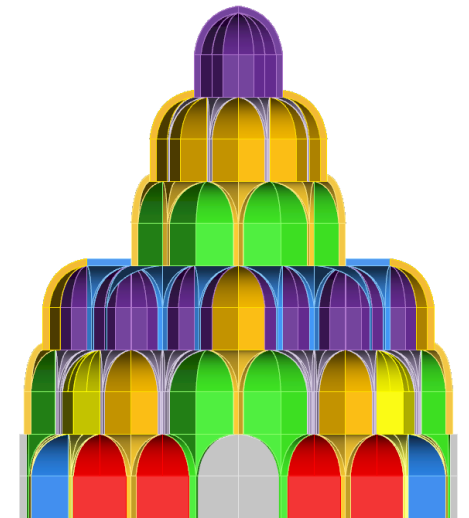
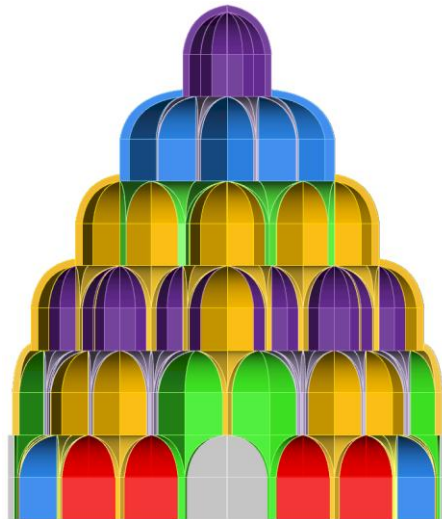
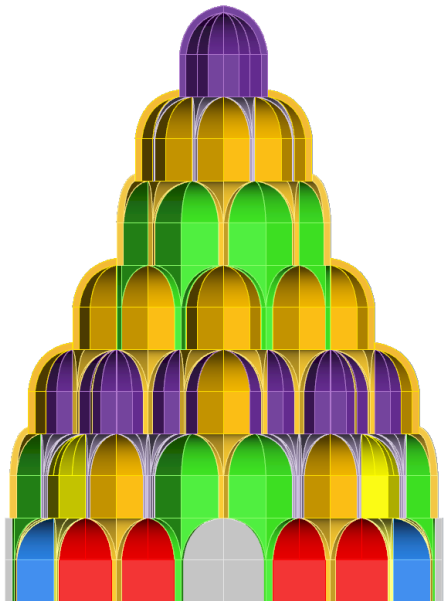
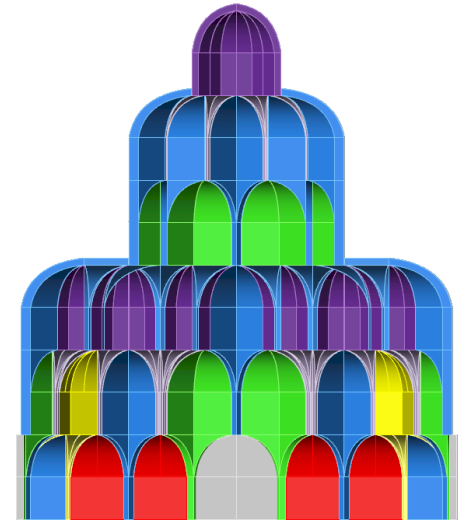
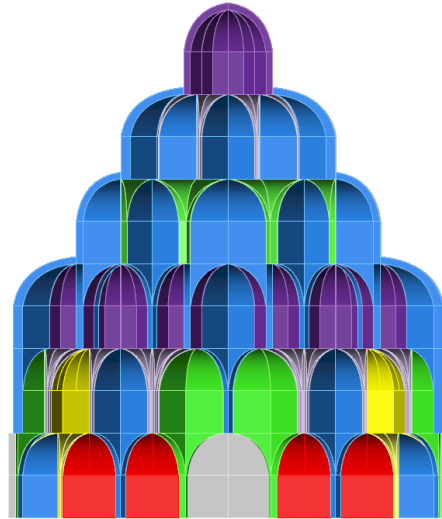
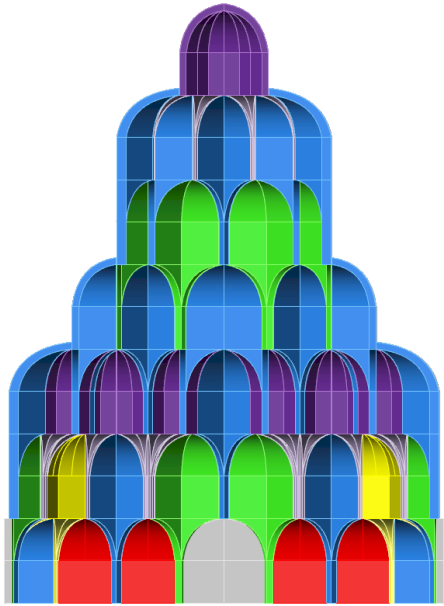
Takht-i Sulayman Southern Octagon



Six possibilities (of many more) to identify tiers and assign units

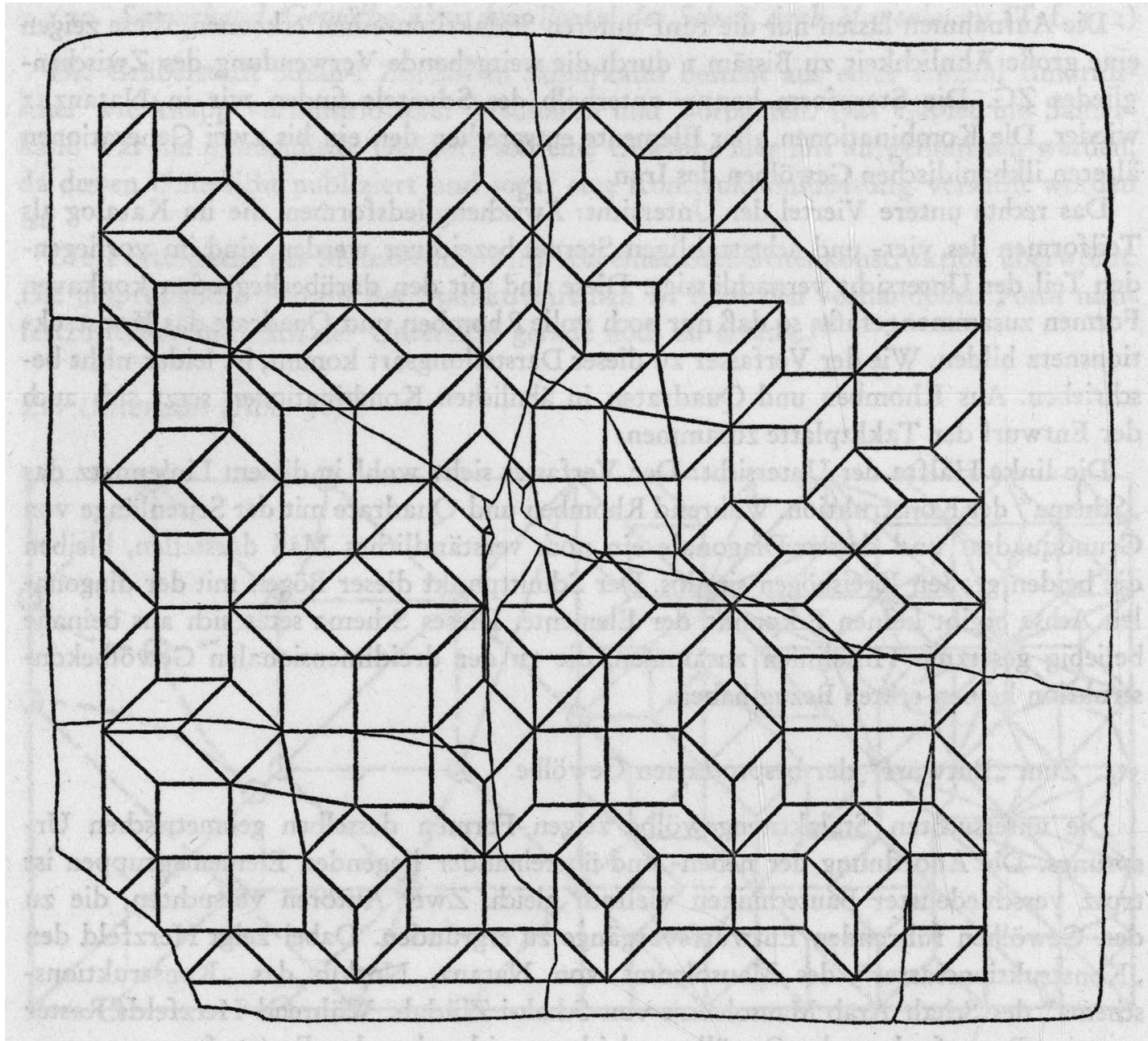


Six possibilities result in six different muqarnas



How to elevate this design from 2D to 3D

Takht-i Sulayman Central Dome



Some possibilities

Quarter of the vault

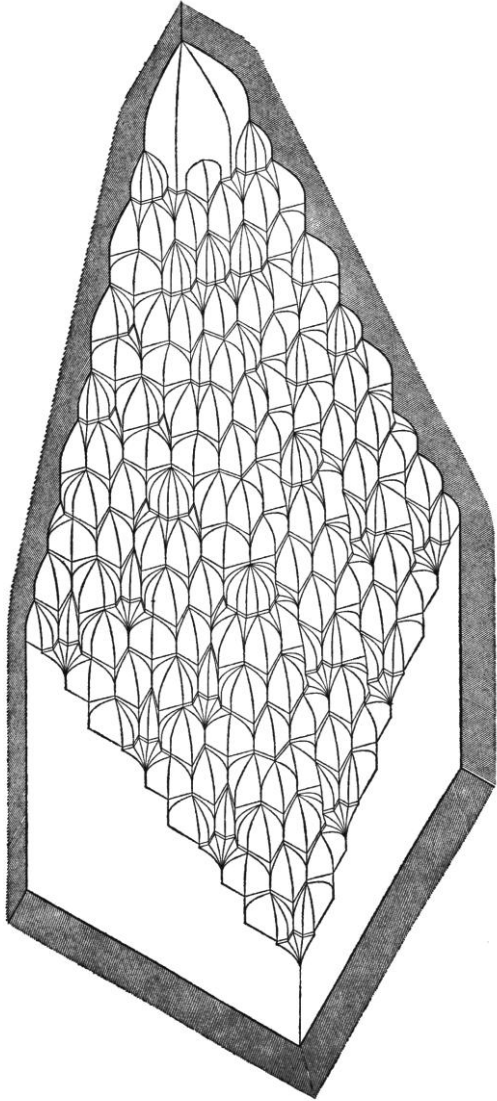
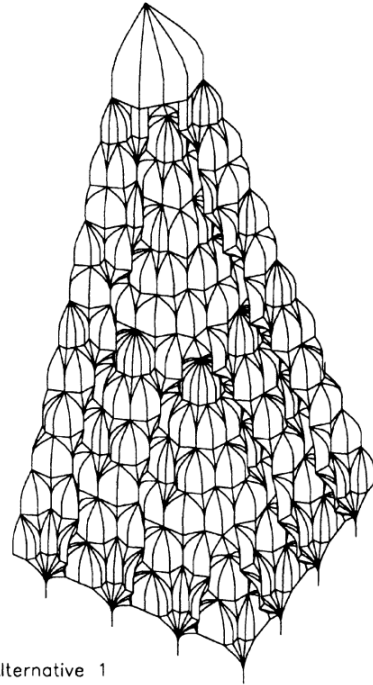
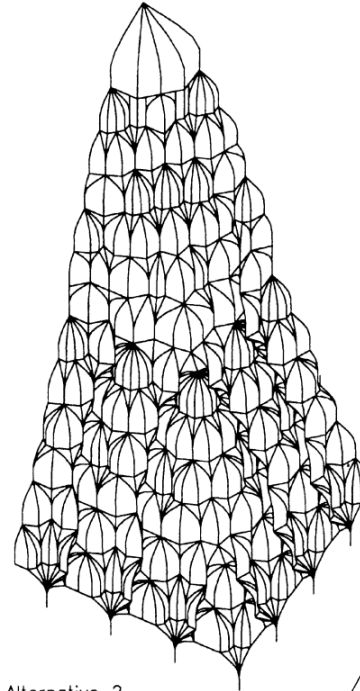


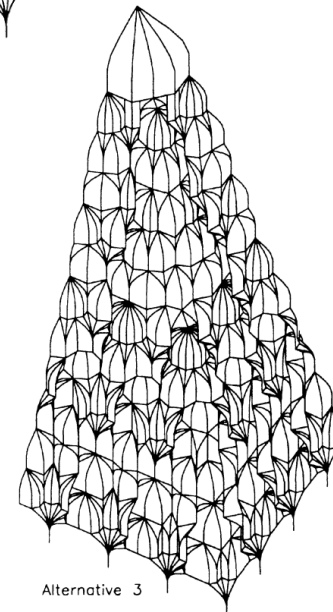
Abb. 33. Rekonstruktionsvorschlag zur Entwurfsplatte
des Takht-i Suleiman, Axonometrie



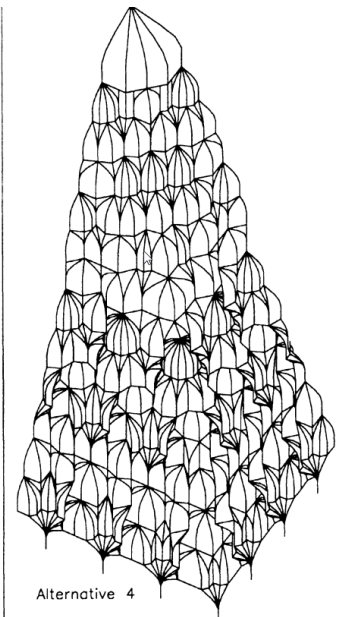
Alternative 1



Alternative 2



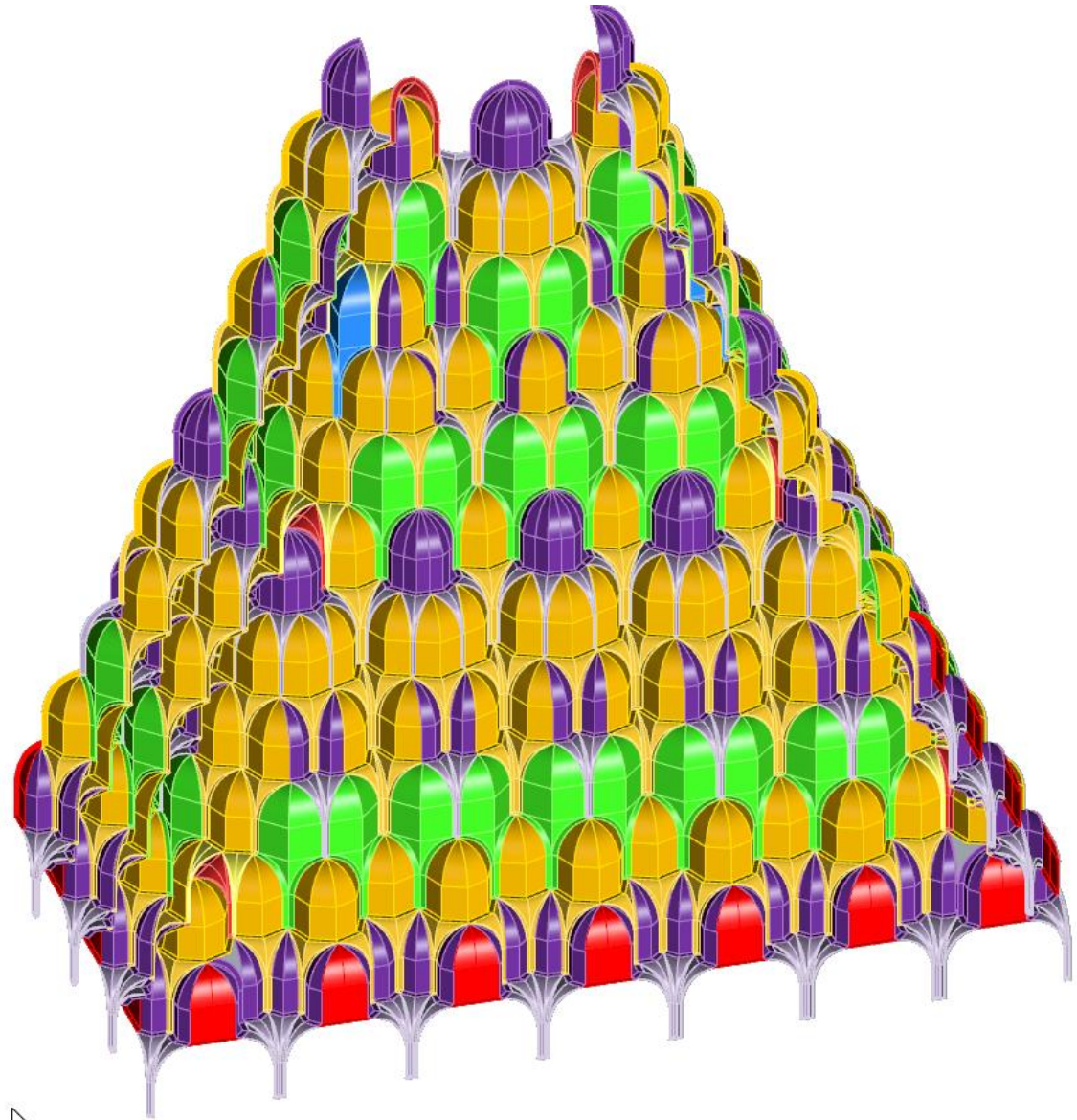
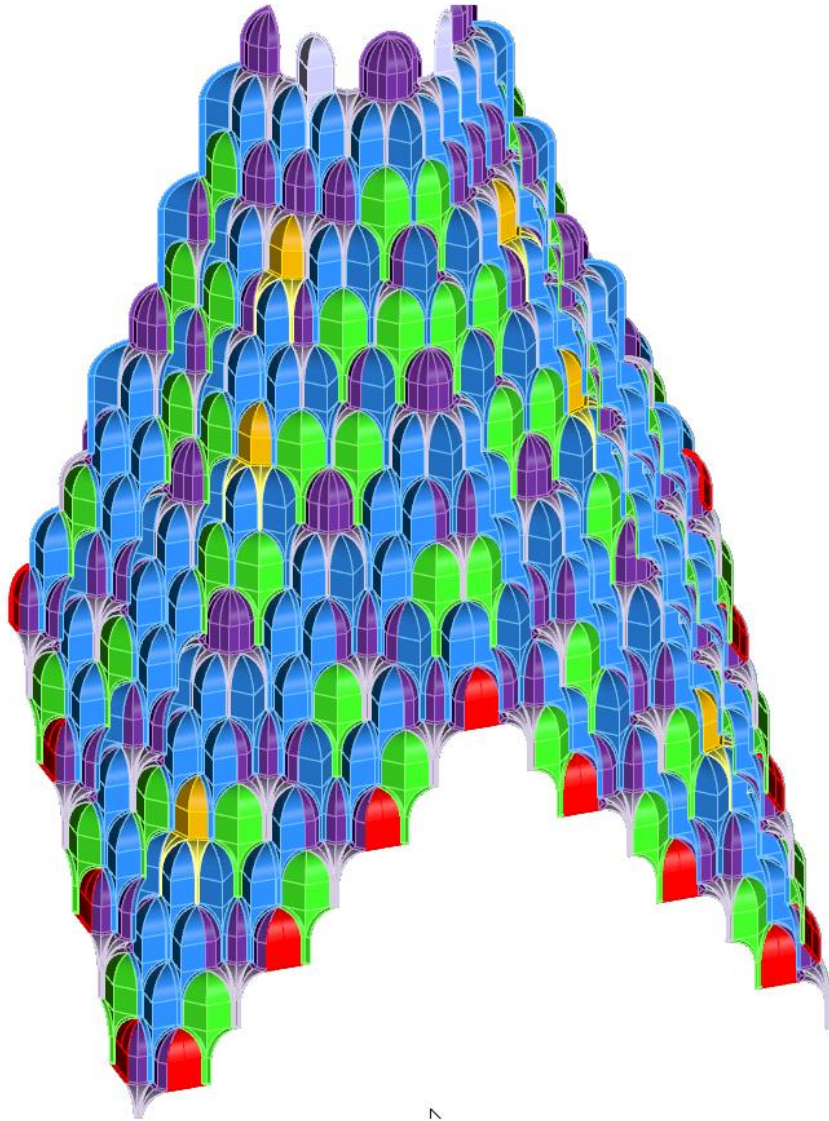
Alternative 3



Alternative 4

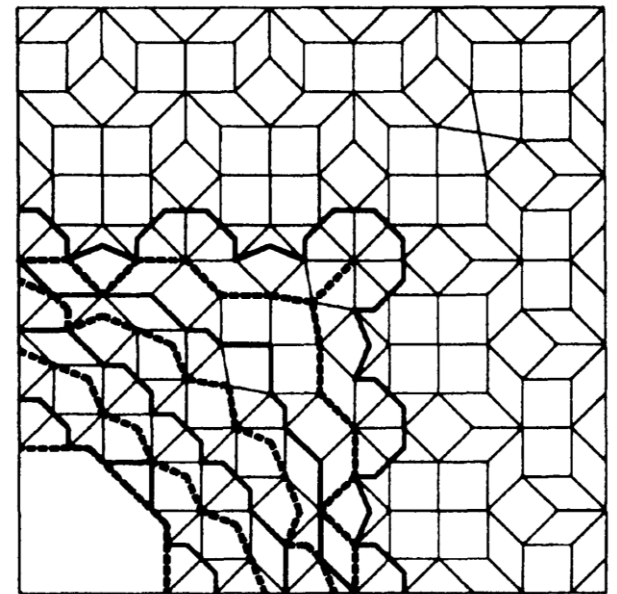
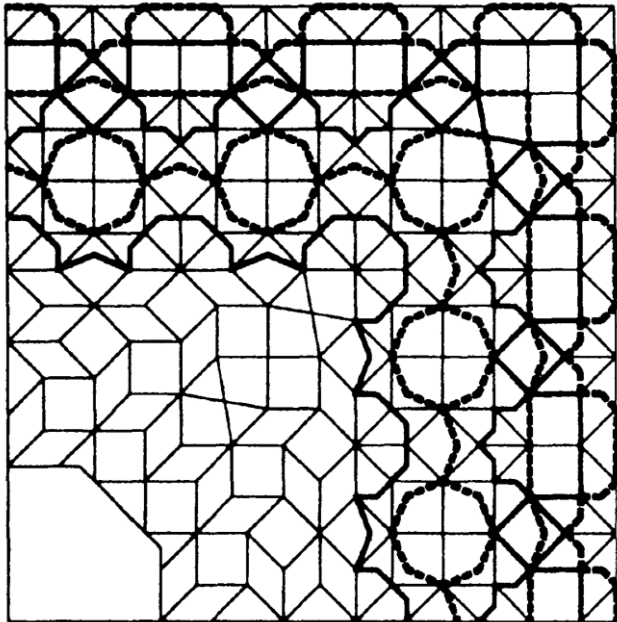
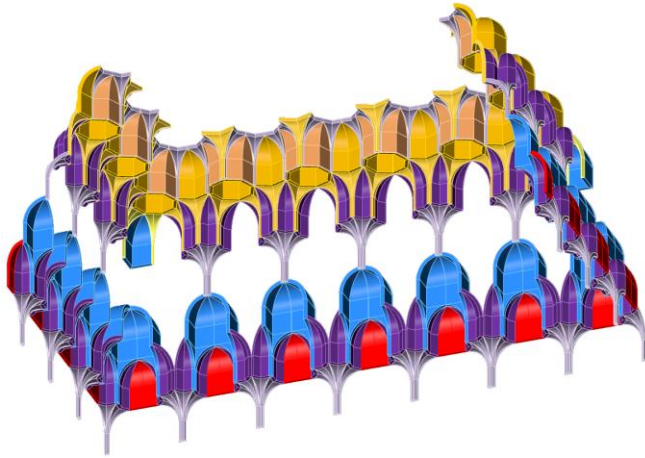
My interpretations of Half of the vault

Only two make sense.

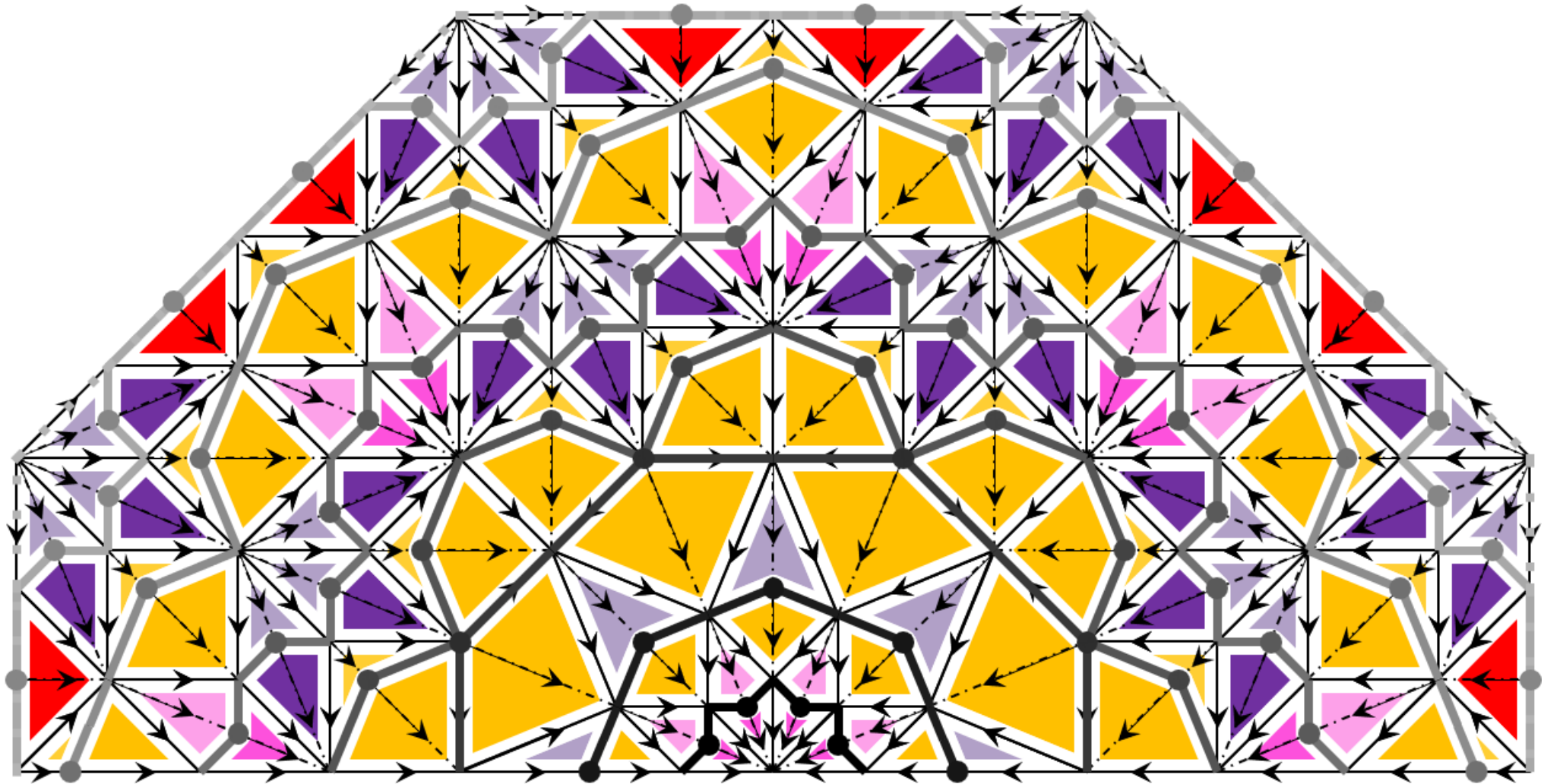


Click on a figure to open the corresponding webpage at www.henkietbrink.nl/muqarnas

**There are gaps in the others.
I didn't understand the floor plan**



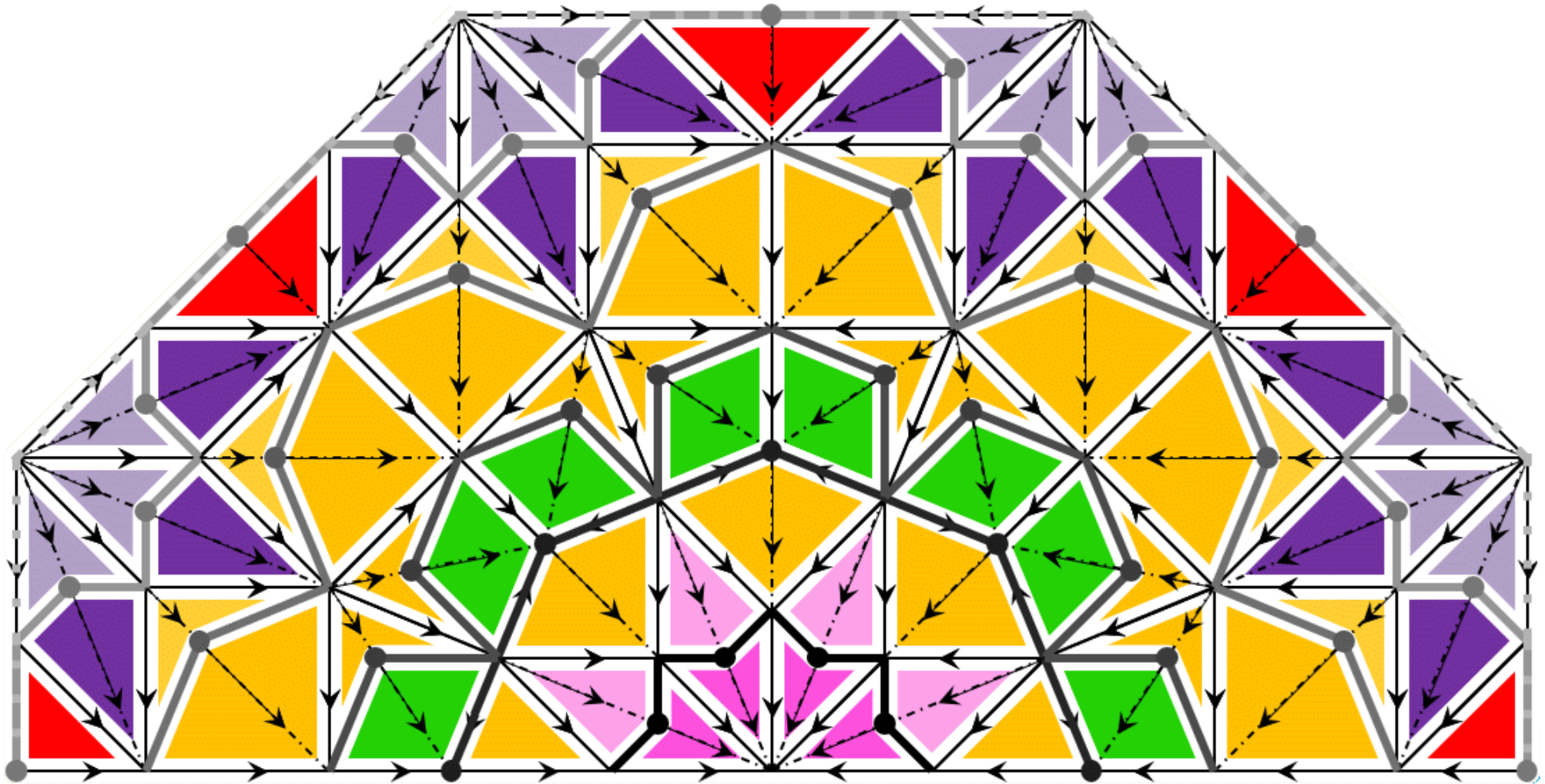
Same shape, different sizes



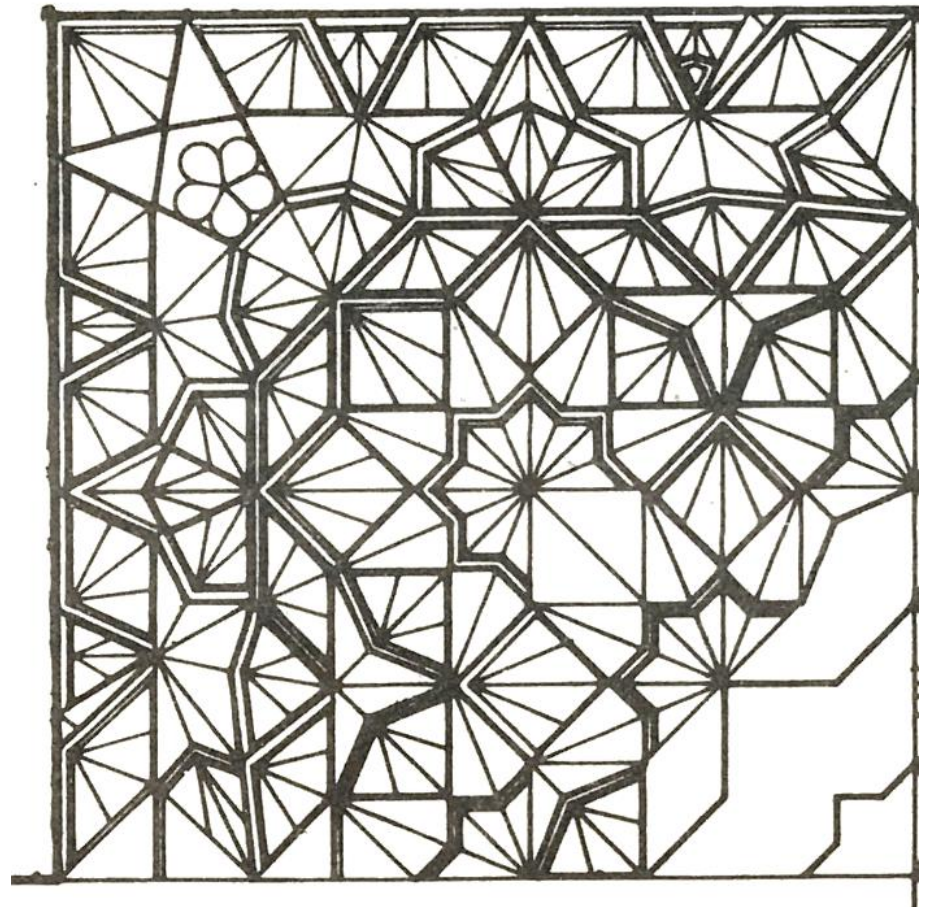
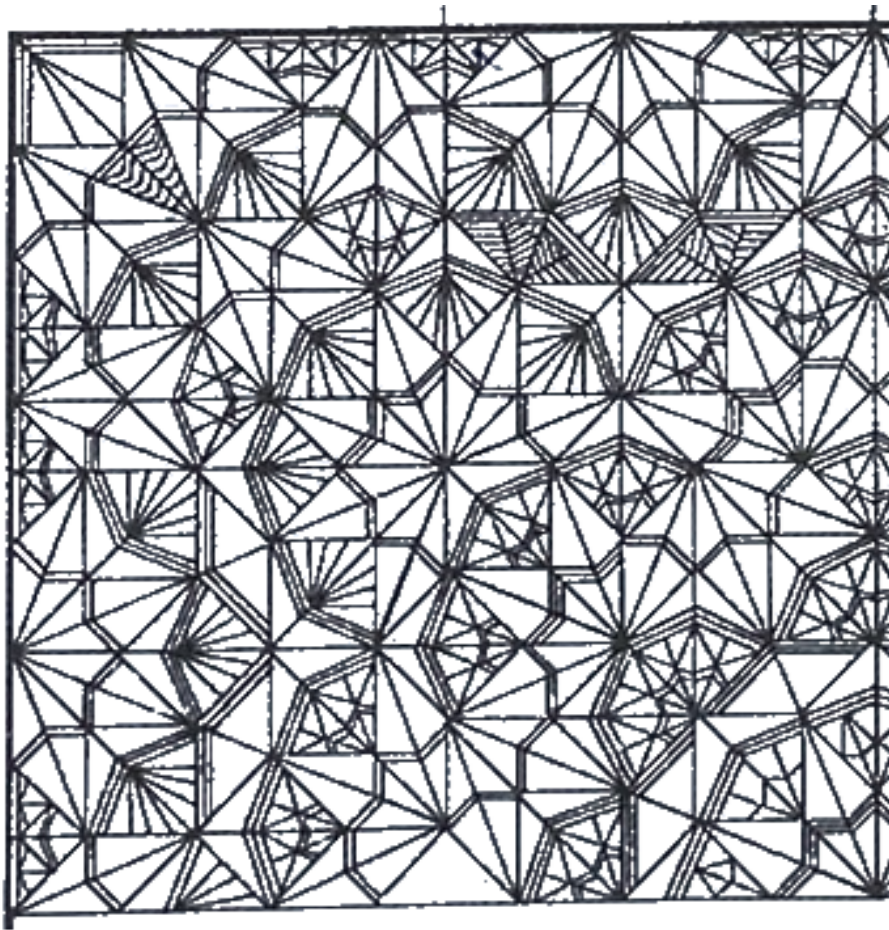
Click on a figure to open the corresponding webpage at www.henkietbrink.nl/muqarnas

Same shape, different sizes

New rhombuses



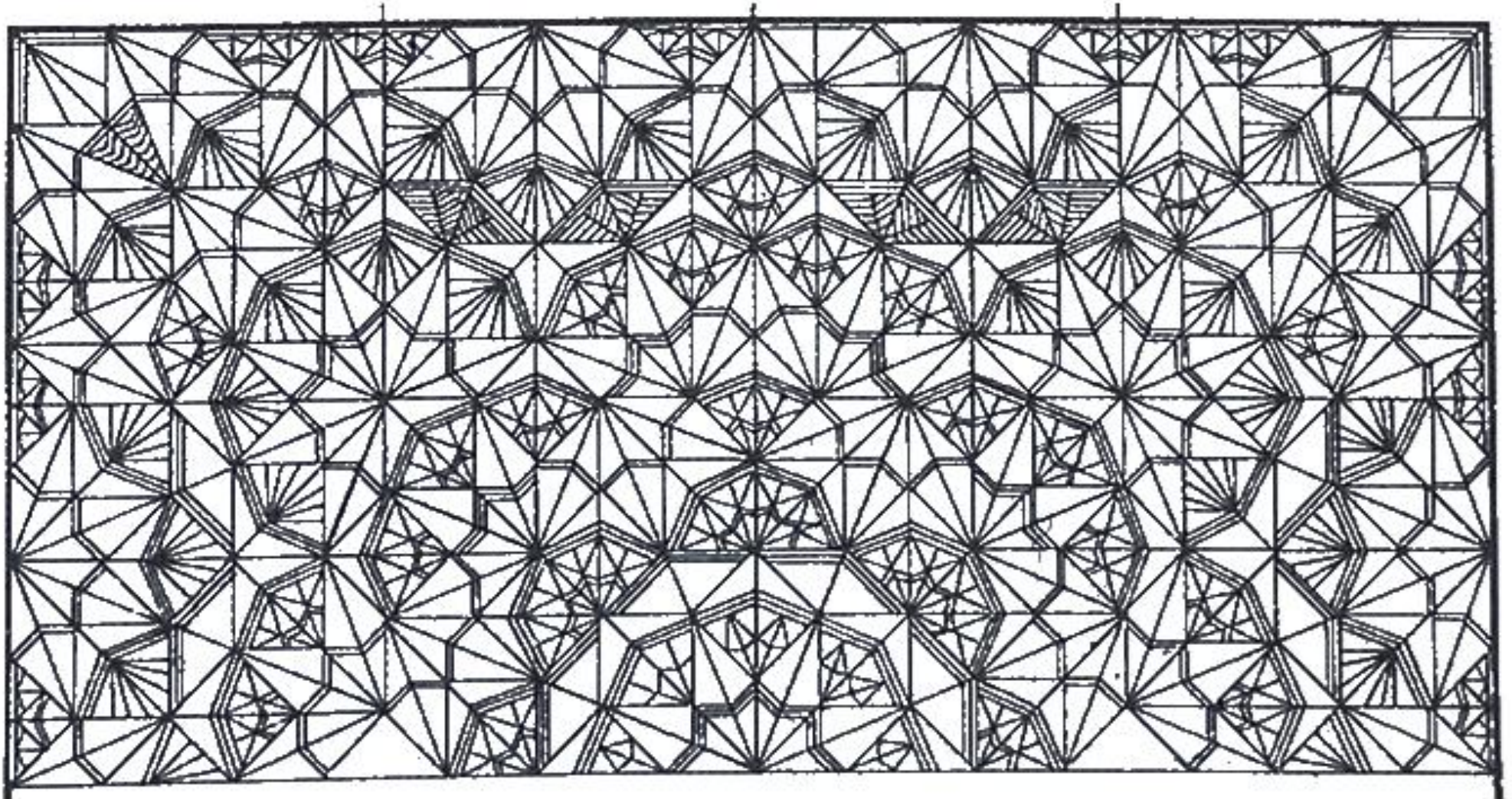
Up or down ?



Mardin Kasim Padisah Up or down

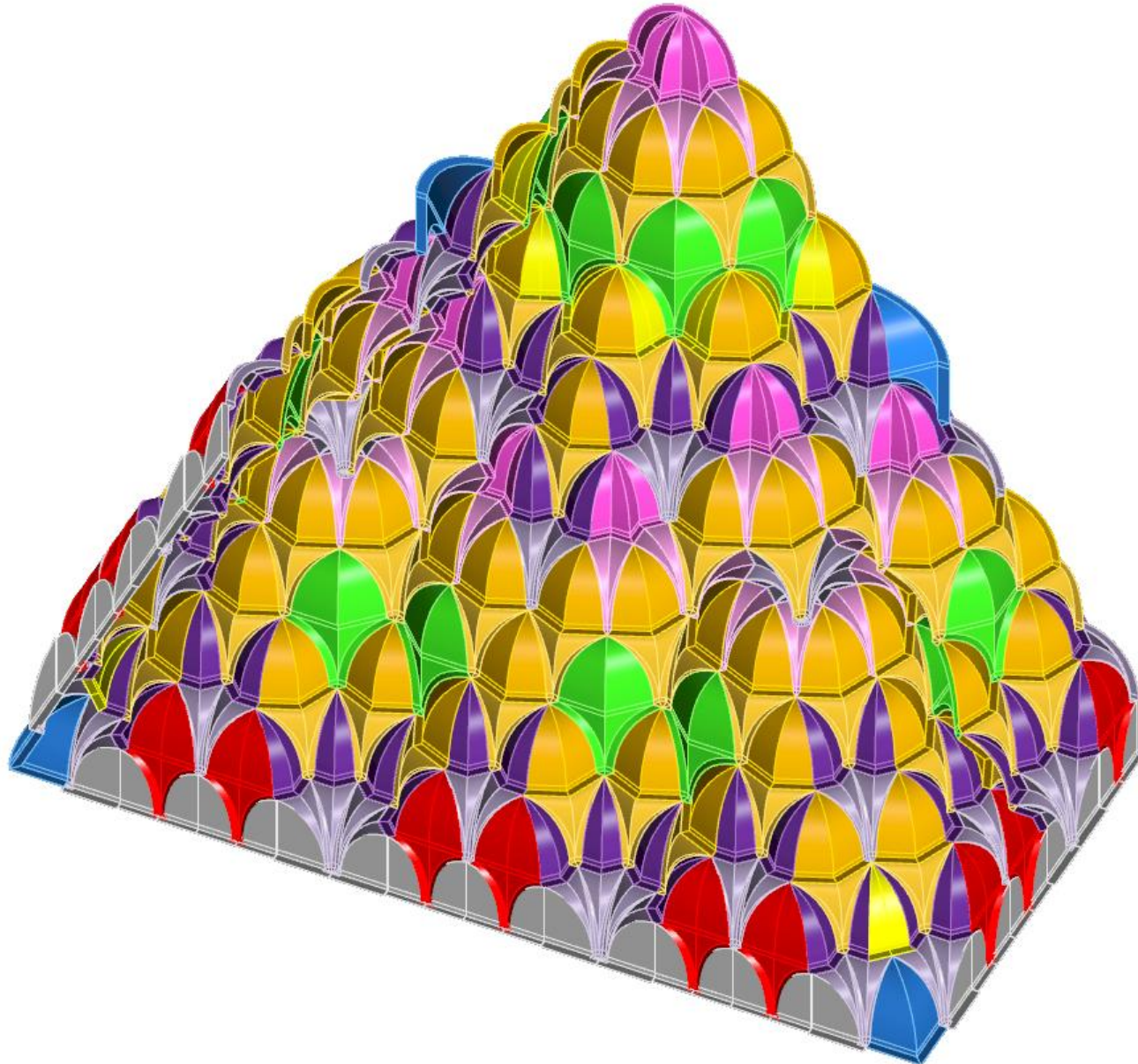
© Prof. Dr. Orhan Cezmi Tuncer

MARDİN KASIM PADİŞAH (KASİMİYE) MEDRESESİ TAÇKAPISI MUKARNASI



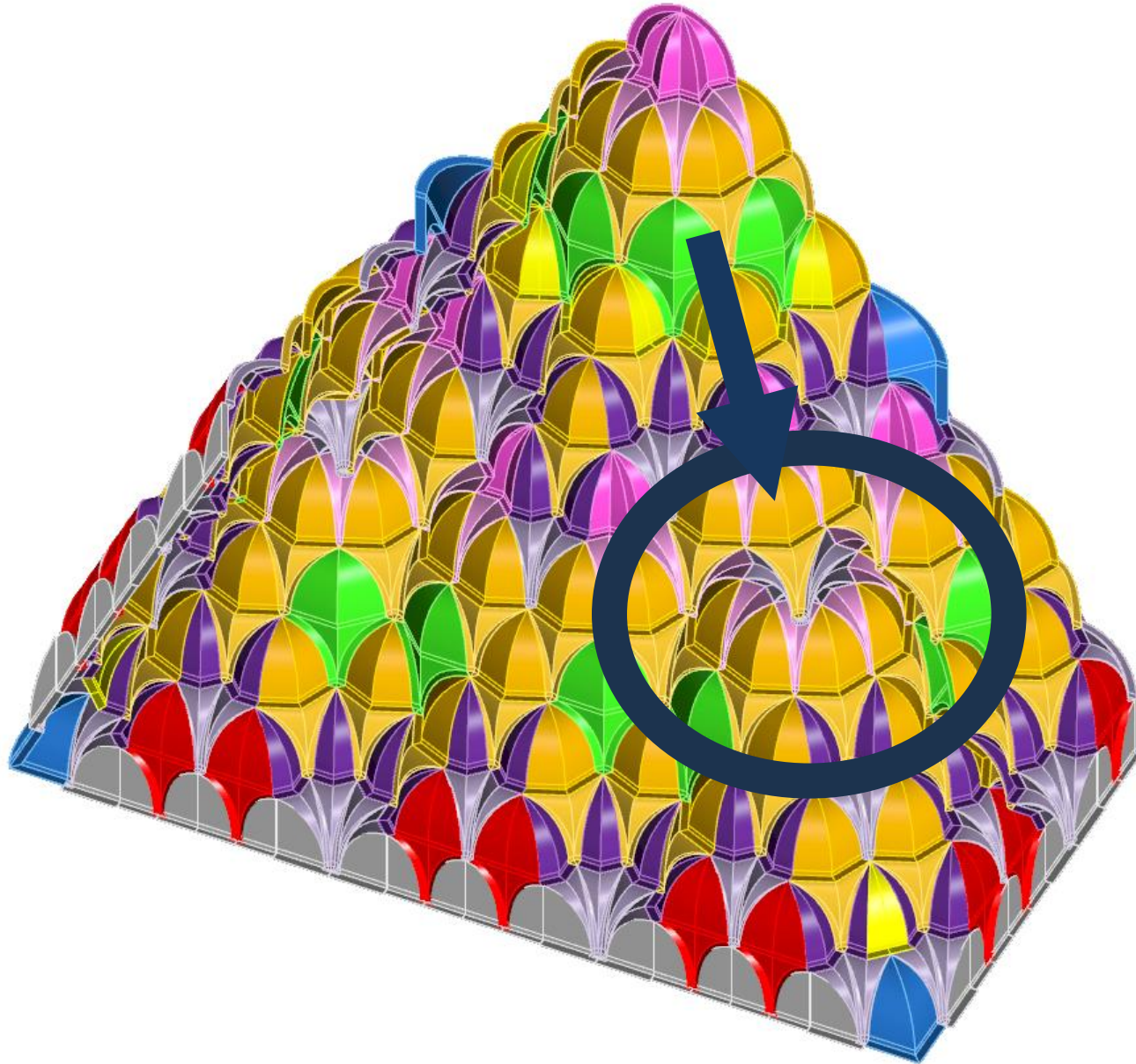
Click on a figure to open the corresponding webpage at www.henkietbrink.nl/muqarnas

Mardin Kasim Padisah goes Down

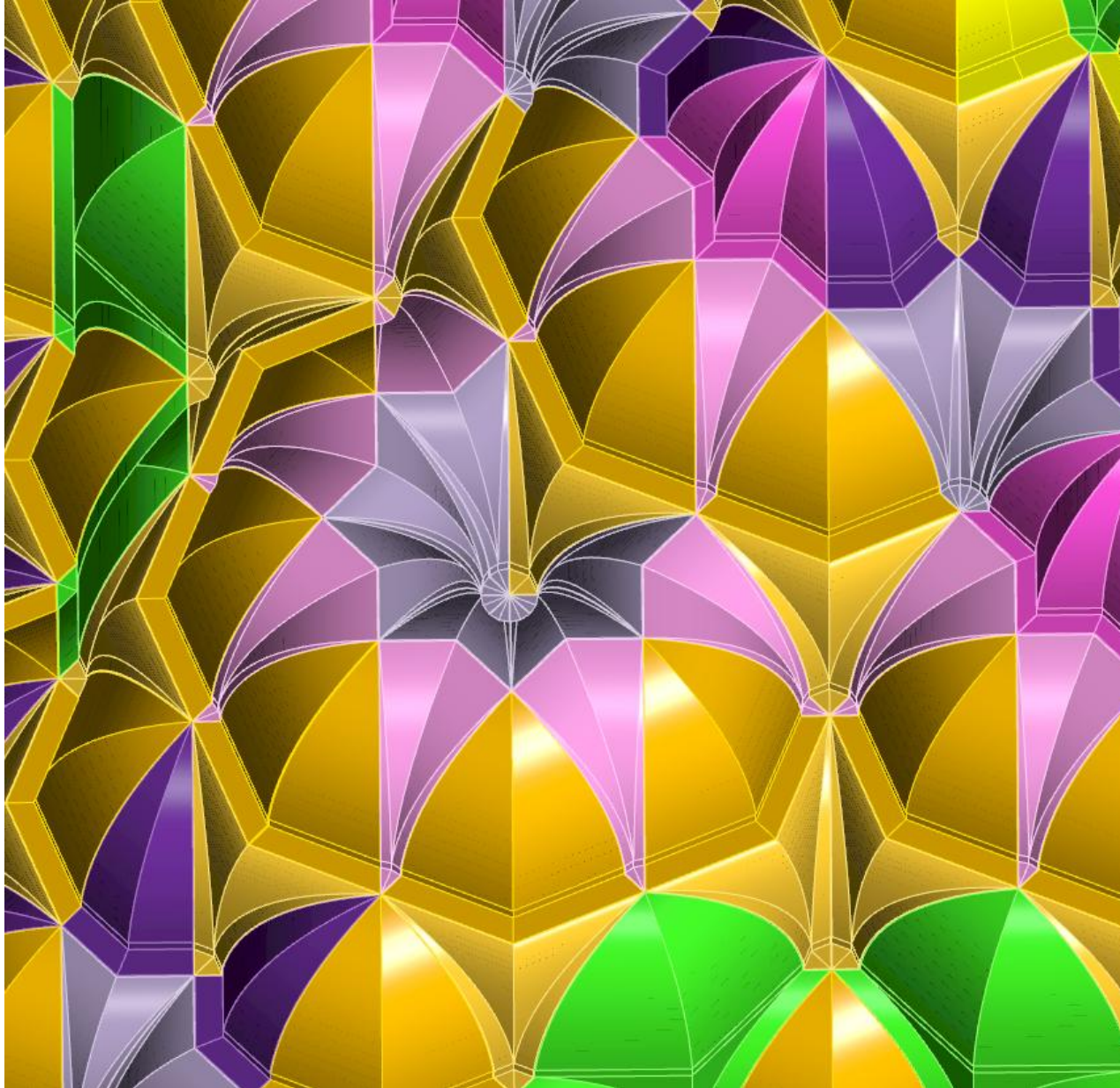


Click on a figure to open the corresponding webpage at www.henkhetbrink.nl/muqarnas

Mardin Kasim Padisah goes Down



Mardin Sultan Isa Medresesi → Down too



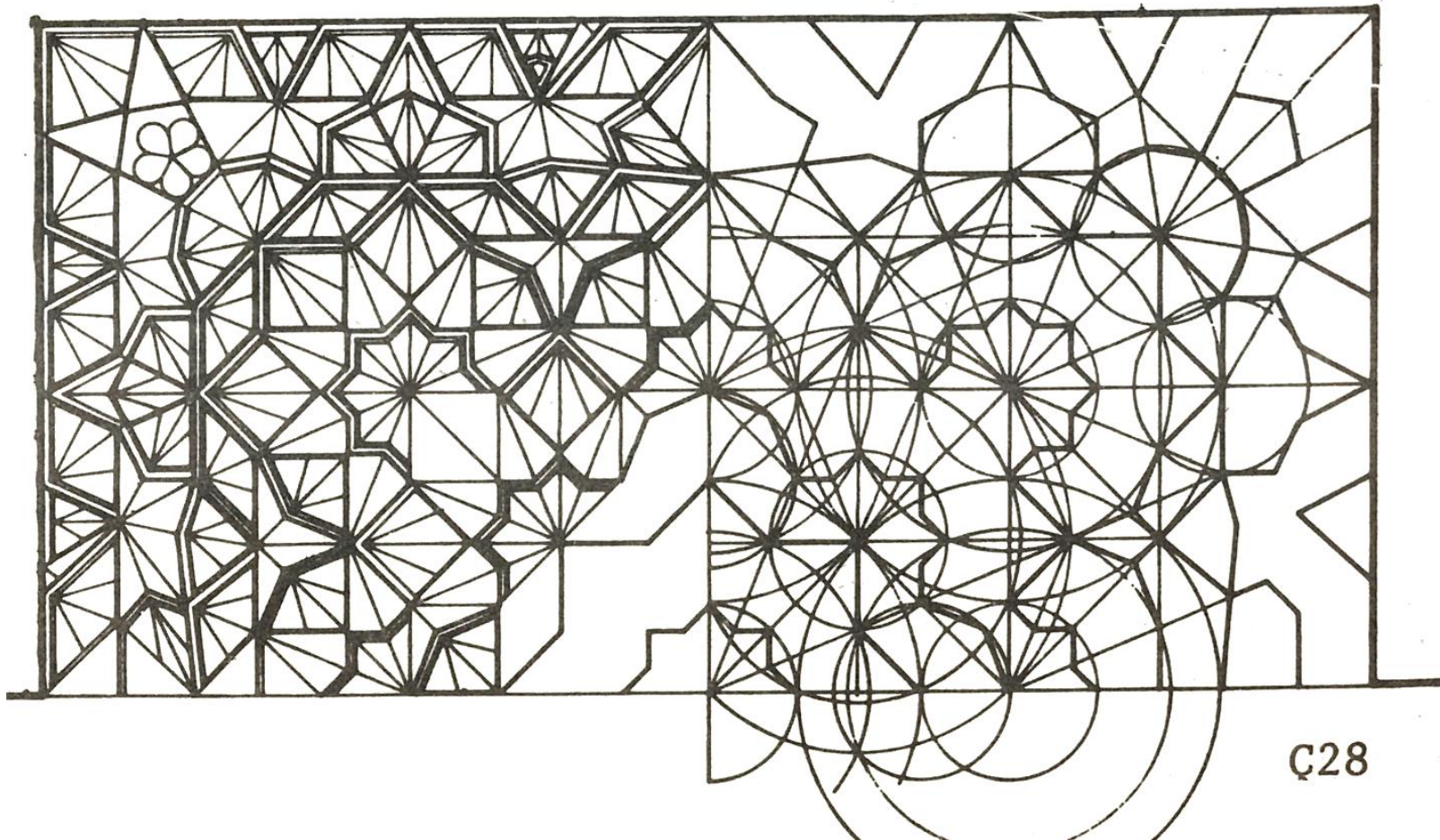
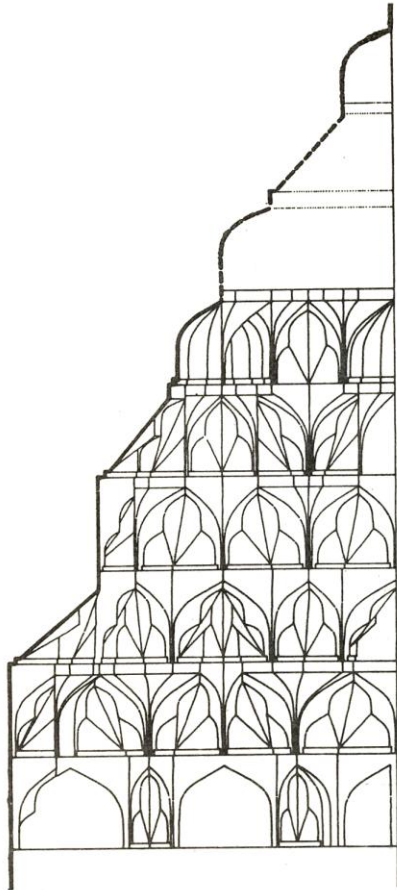
Example

Diyarbakır Iskender Pasa

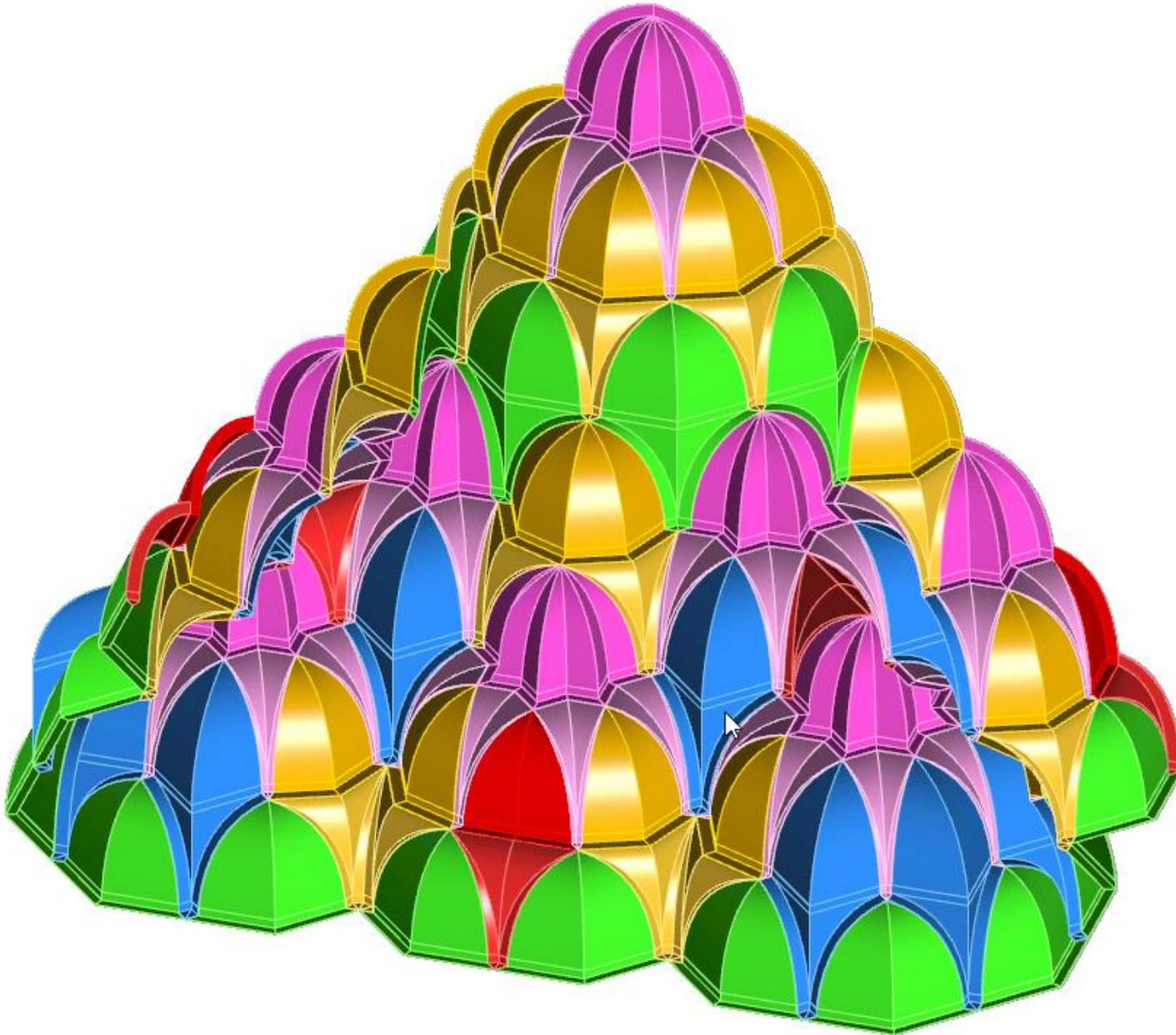


Kayseri Sultan Han on the Kayseri Sivas Road

Up or down © Prof. Dr. Ayla Ödekan



Kayseri Sultan Han goes Up



Kayseri Sultan Han goes Up



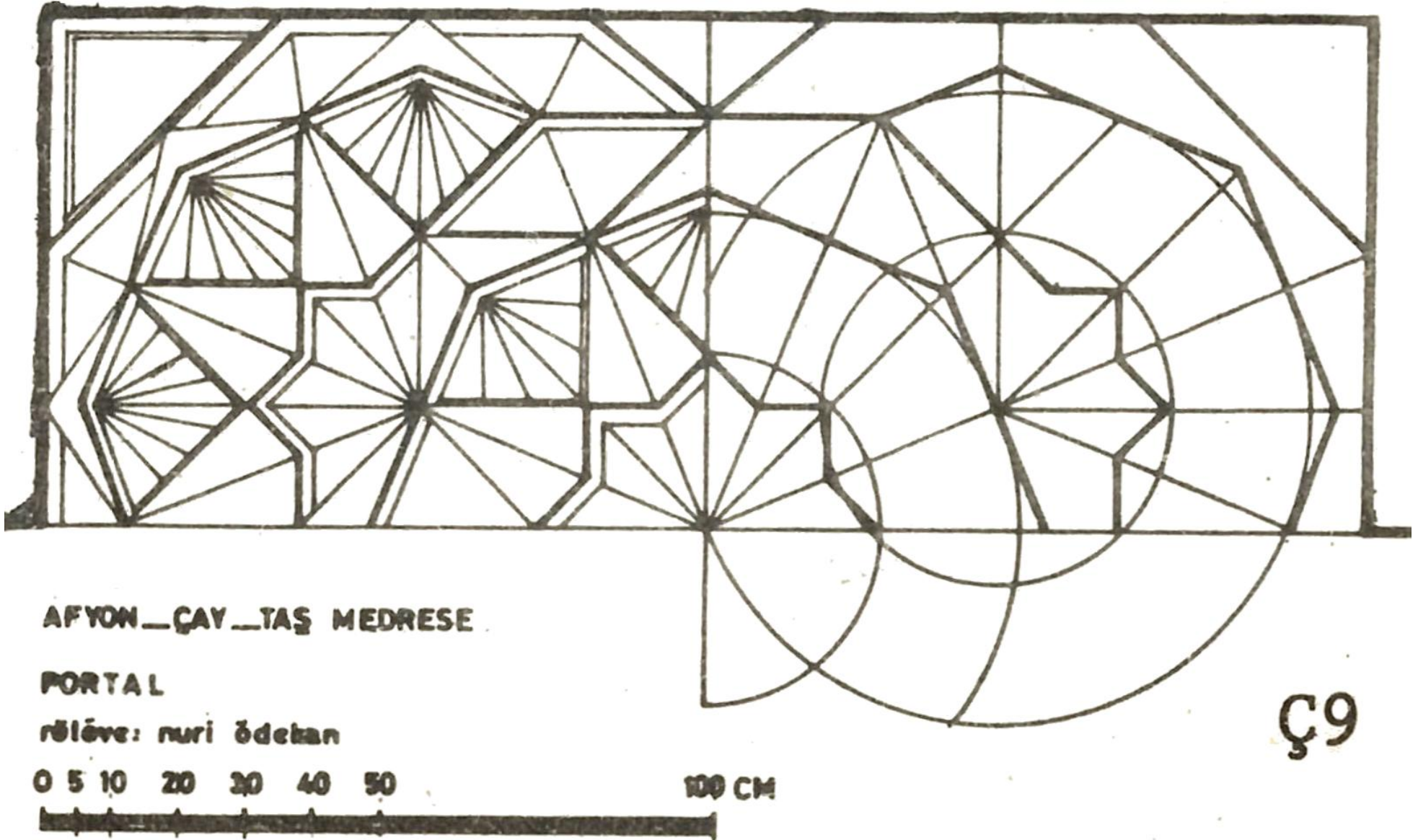
Click on a figure to open the corresponding webpage at www.henkhietbrink.nl/muqarnas

Kayseri Sultan Han goes Up



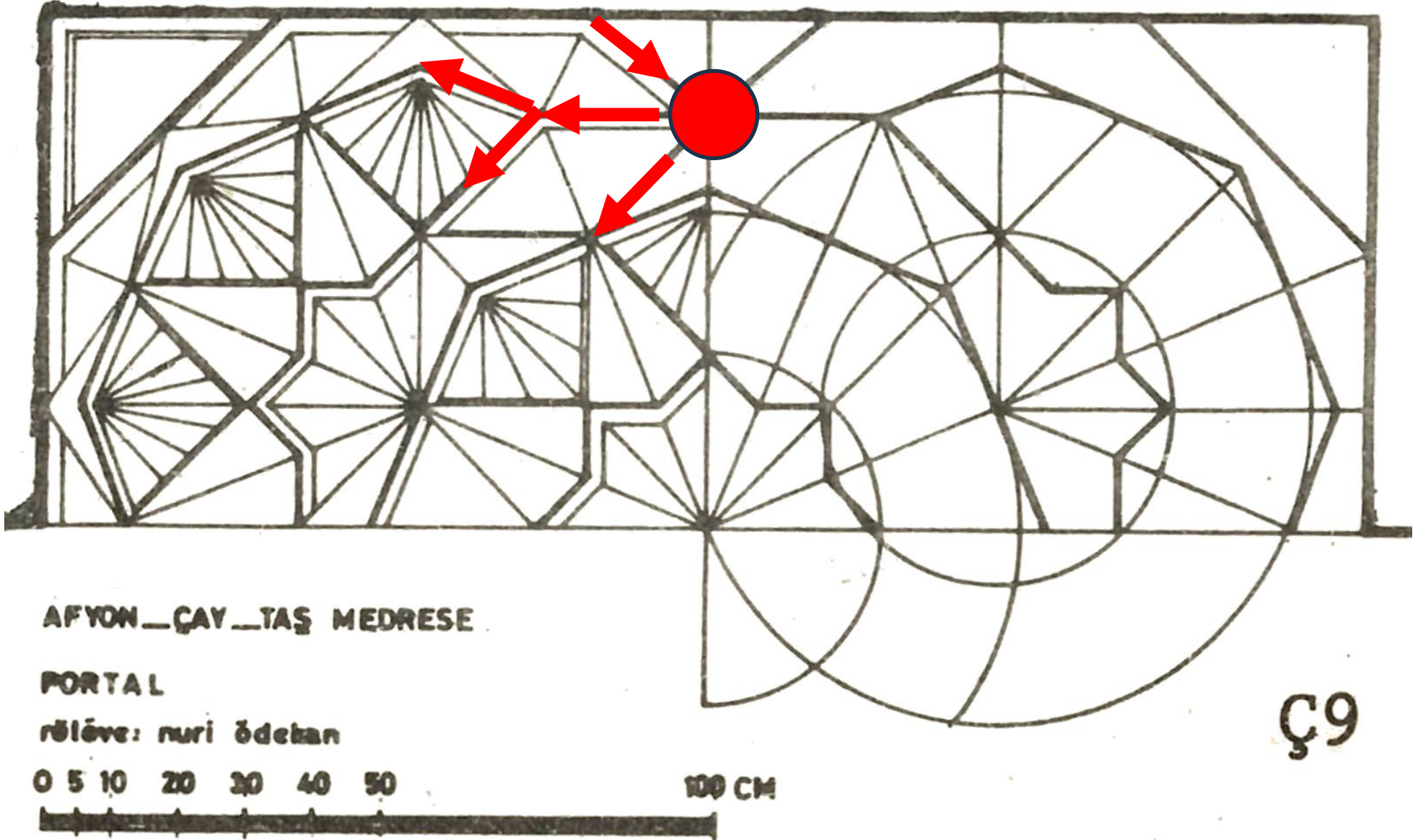
Afyon Tas Medrese: Consecutive Tiers?

© Prof. Dr. Ayla Ödekan



Afyon Tas Medrese: Consecutive Tiers?

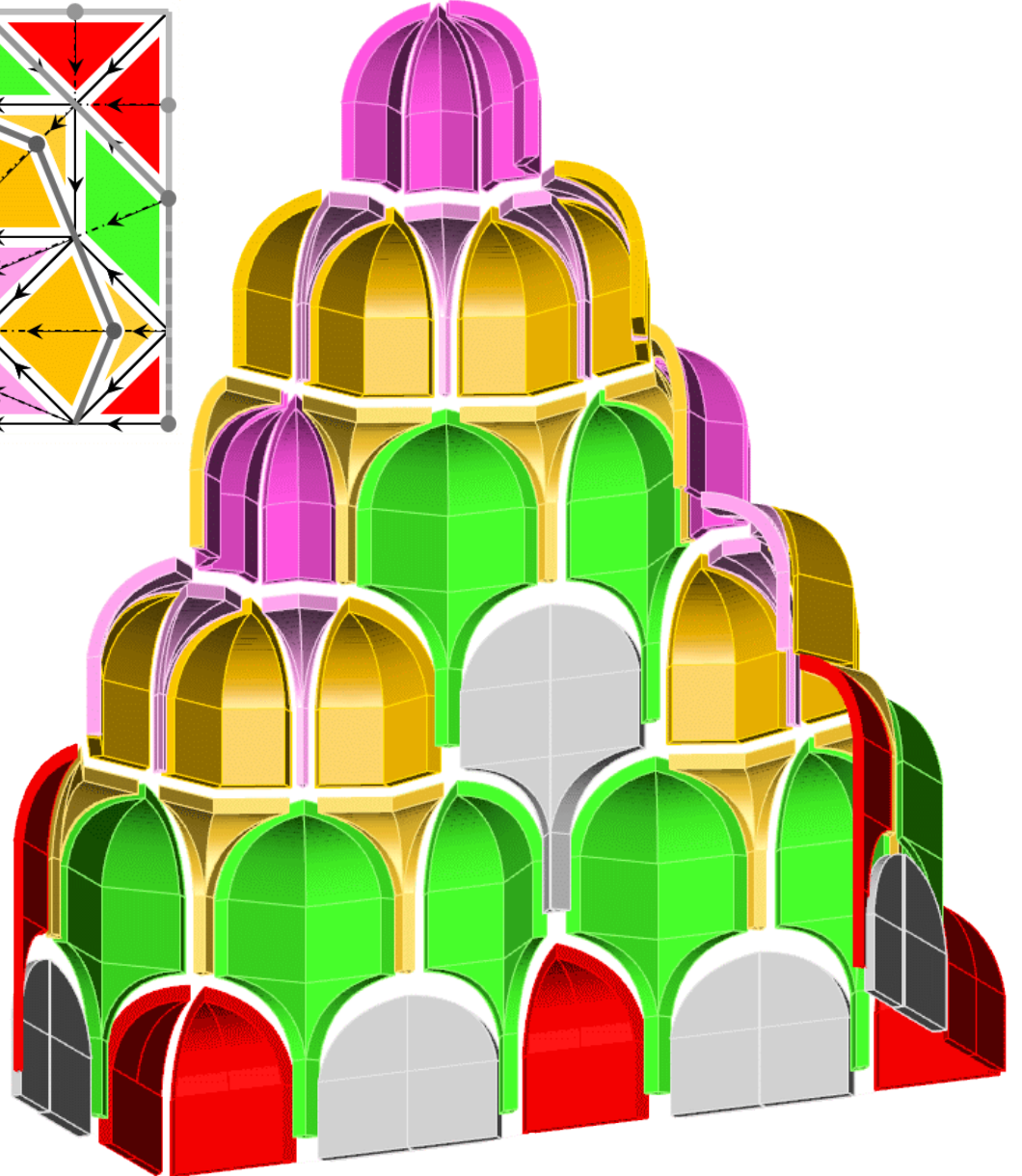
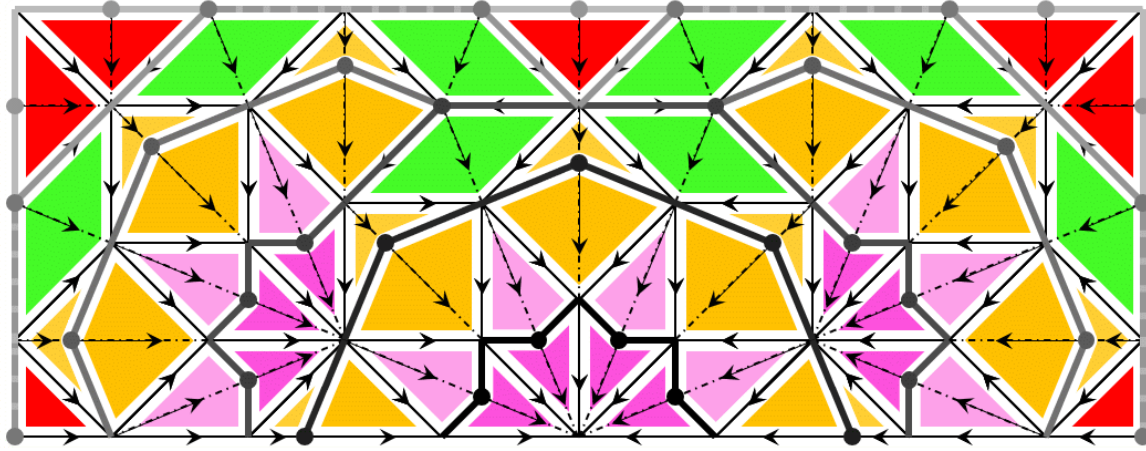
© Prof. Dr. Ayla Ödekan



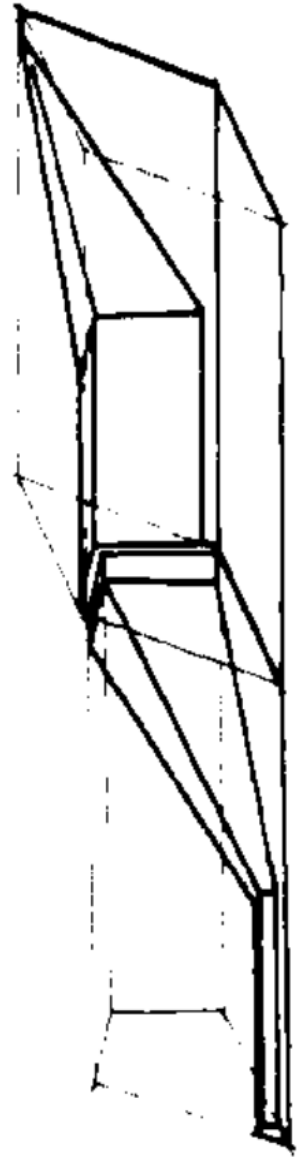
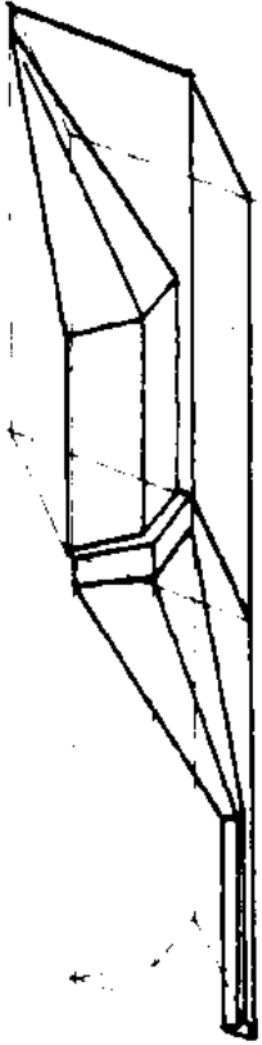
Afyon Tas Medrese



Afyon Tas Medrese



Example from Bursa Muradiye Complex



Example from Bursa Muradiye Complex

Exceptional pentagons



Click on a figure to open the corresponding webpage at www.henkhetbrink.nl/muqarnas

Istanbul Üsküdar Atik Valide Mosque

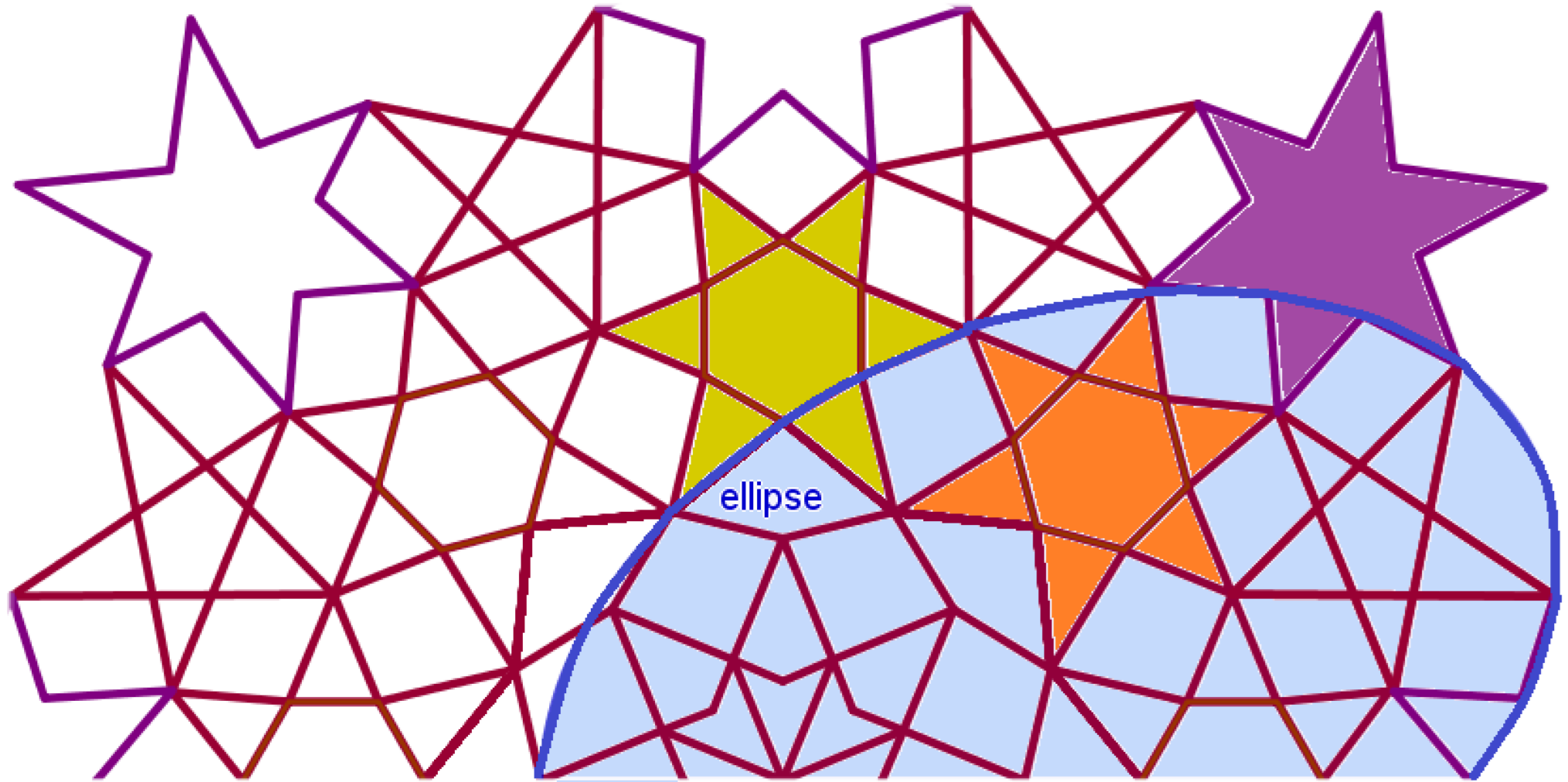
Curved lines, Pentagons, Hexagons



Click on a figure to open the corresponding webpage at www.henkietbrink.nl/muqarnas

New ideas about the grid

Agirbas suggests an elliptical grid



Conclusion

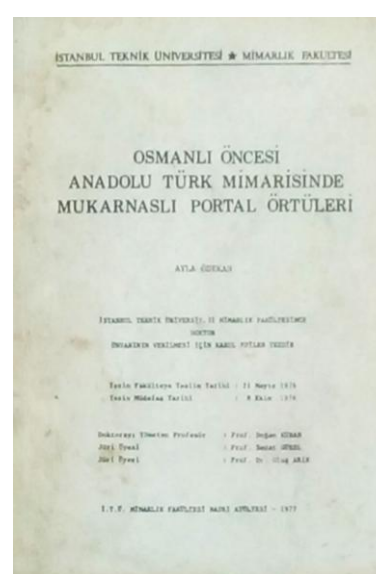
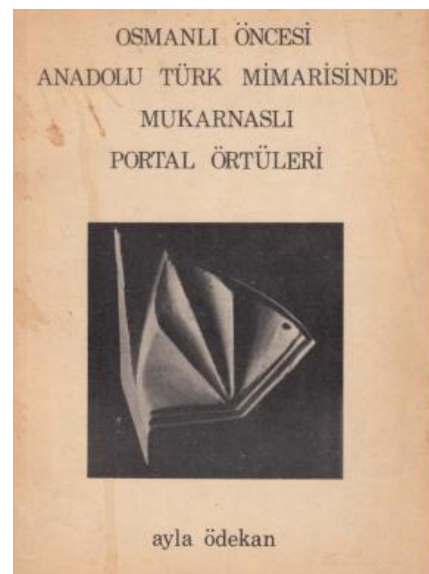
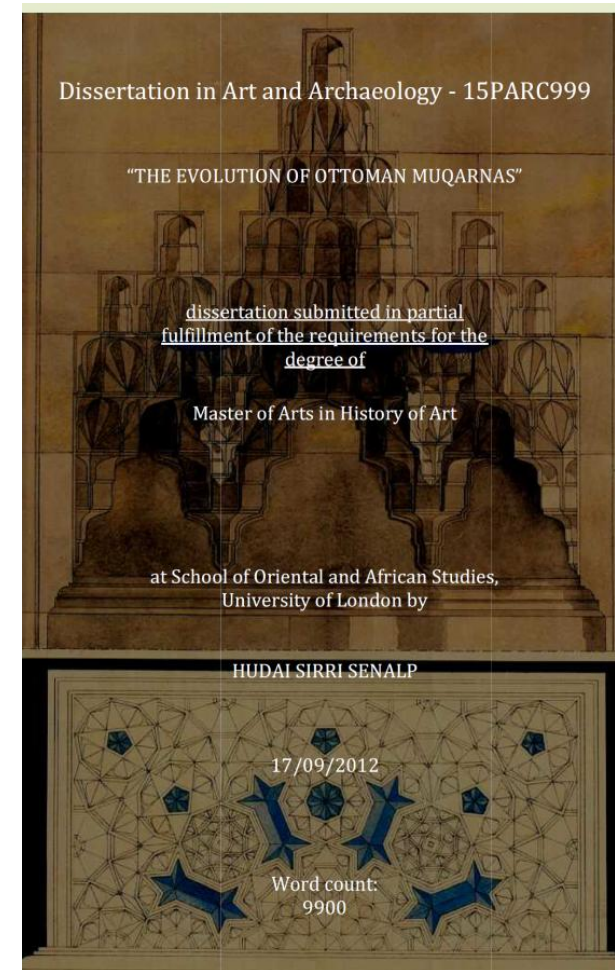
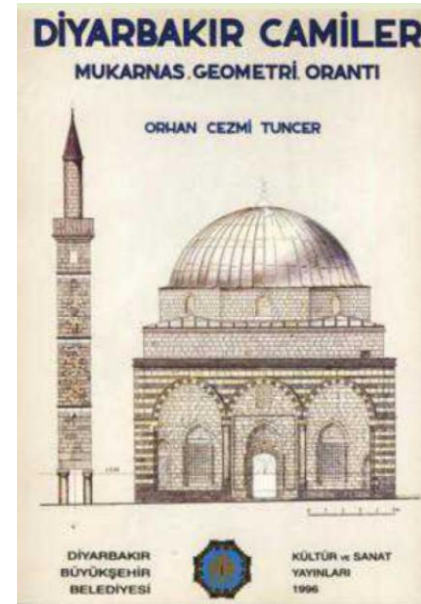
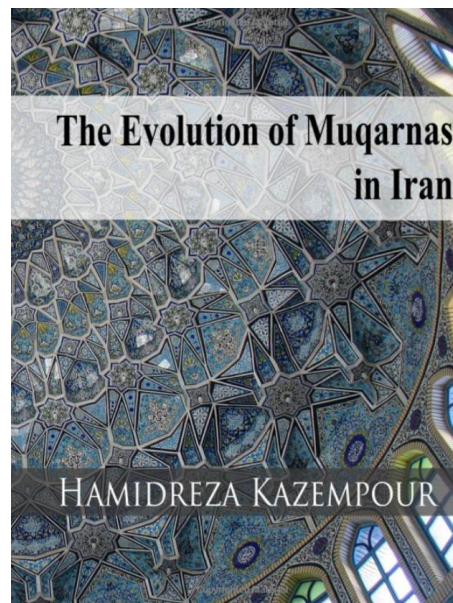
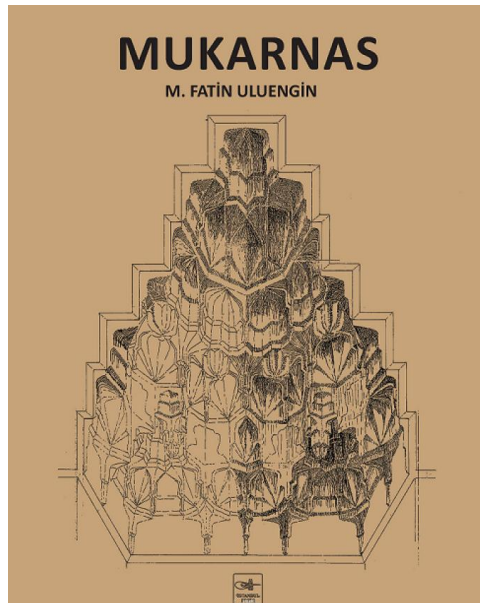
- **Muqarnas are not easy**
 - Huge variety
 - Exceptional constructions
 - It's art, not mathematics
- **Parametric software is a powerful tool**
 - Generating 2D floor plan
 - Generating 3D images and 3D prints
- **3D animations are essential**
 - to find correct interpretation of floor plans

Solution to understand Turkish muqarnas

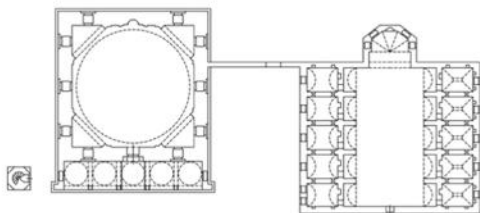
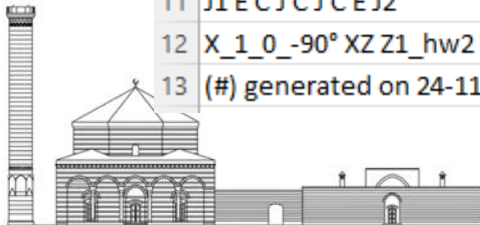
- **Go there, stay there**
 - Visit all the places
 - Both the touristic hotspots and the unknown places
- **Desk research is essential**
 - but even better is measuring the muqarnas on site
- **Talk to local architects and engineers**
- **Learn Turkish: read books and papers**
 - Lot of literature
 - PhD thesis, for example Senalp

Study muqarnas

https://www.fransvanschooten.nl/muqarnas_literature.htm



Create muqarnas



Create

1 Diyarbakir Kasim Padisah Son Cemaat Yeri

2

3 (#) Tuncer page 223

4 (#) >_D,M,N

5 (%_hw2_1_1) M

6 (%_hw2_1_1) D1 N D2

7 (%_hw4p2w2_1_1) I1 D I2

8 D~H D

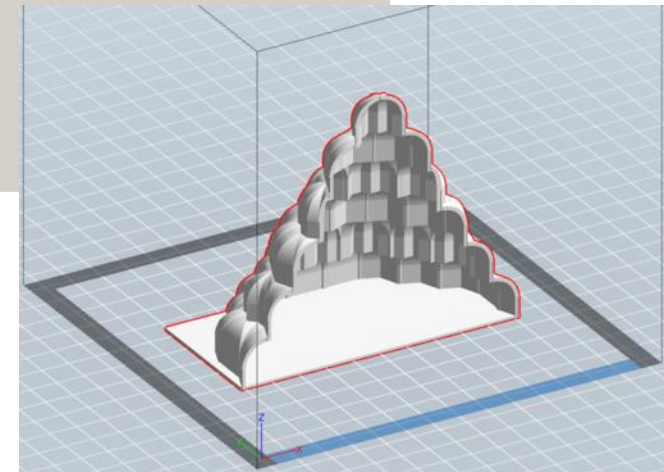
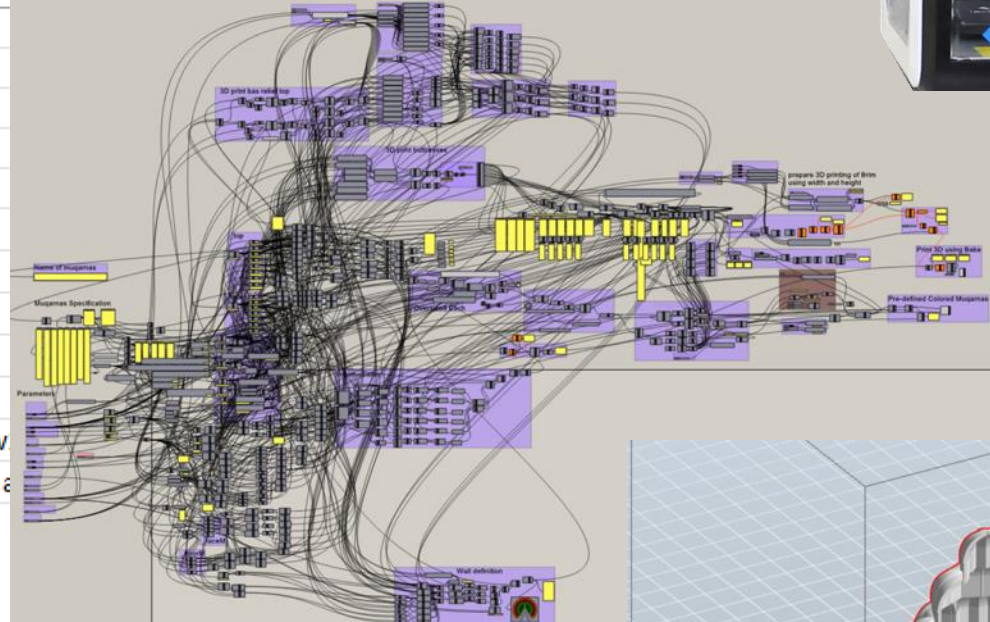
9 M C J C J C M

10 D1 N D I I I D N D2

11 J1 E C J C J C E J2

12 X_1_0_-90° XZ Z1_hw2 Z2_hw

13 (#) generated on 24-11-2021 at 10:10:10



Thanks for your attention

