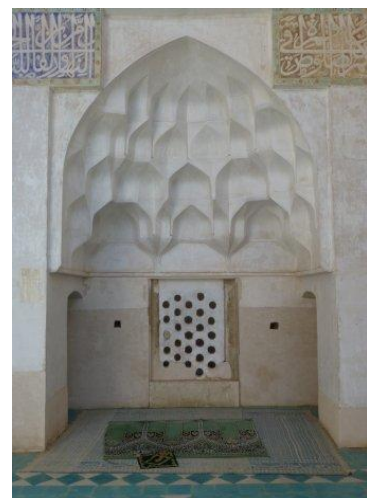


# Handout Muqarnas Workshop

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Muqarnas can be found everywhere in Islamic architecture, from Spain, Morocco, Egypt, Turkey, Iran and Uzbekistan to Afghanistan. Below there are pictures of a mosque in Natanz, a city in Iran. Muqarnas are those whimsical, graceful elements you see on the bottom row. If you look closely, you can also see the regularity.



# Only twelve building blocks

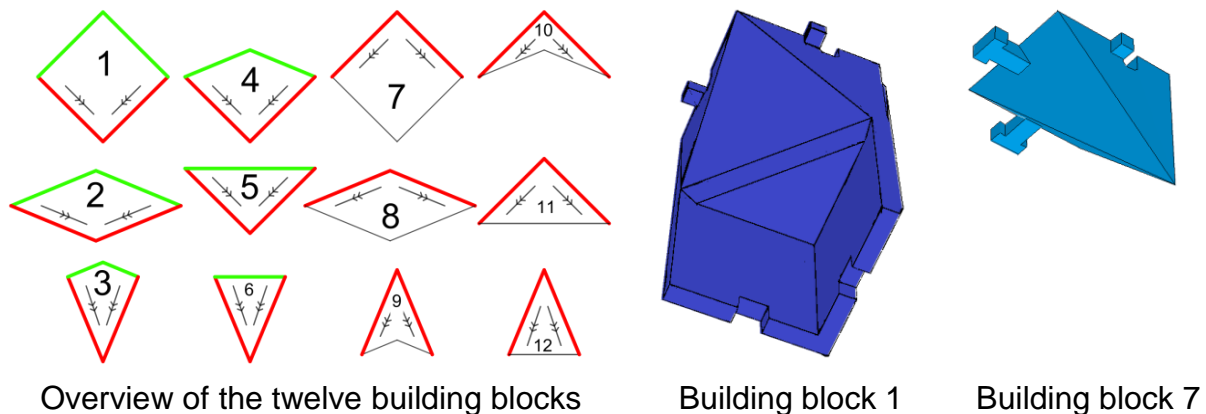
You can build a muqarnas with a system based on twelve different building blocks. The upper surface of each building block is a triangle or quadrangle whose angles are a multiple of  $22.5^\circ$ , for example  $45^\circ$ ,  $67.5^\circ$ ,  $90^\circ$  or  $135^\circ$ .

A muqarnas consists of several horizontal building layers, where the upper layer fits perfectly to the preceding lower layer. The twelve building blocks are combined all together. The number of combinations appears to be very large. However, many combinations are unsuitable, as it is often not possible to connect the upper level to the lower level. In addition, one combination is less beautiful than the other.

Traditional designers cherish symmetry and regularity and many combinations are not beautiful in their eyes.

Six of the twelve building blocks have a long back wall. Of course, all back walls are the same height. This guarantees that building layers are perfectly horizontal. In the overview, the location of the back wall is marked in green. All building blocks have a cell. That cell looks like a top down pyramid. So the base of that pyramid is the top surface of the building block. The building blocks with a long back wall have a cell that points from the back wall diagonally to the front and above. The building blocks without a back wall have a point at their bottom. From above they have a triangle or quadrangle as upper surface. In the overview the forward direction of the sides of each cell is indicated by red arrows.

Thanks to the green marking of the back wall and the direction of the arrows, you know from each figure in the overview what the building block looks like.



The first building block 1 has a back wall consisting of two parts making a right angle with each other. It has at the top two connectors that connect the different building blocks to each other to form a building layer.

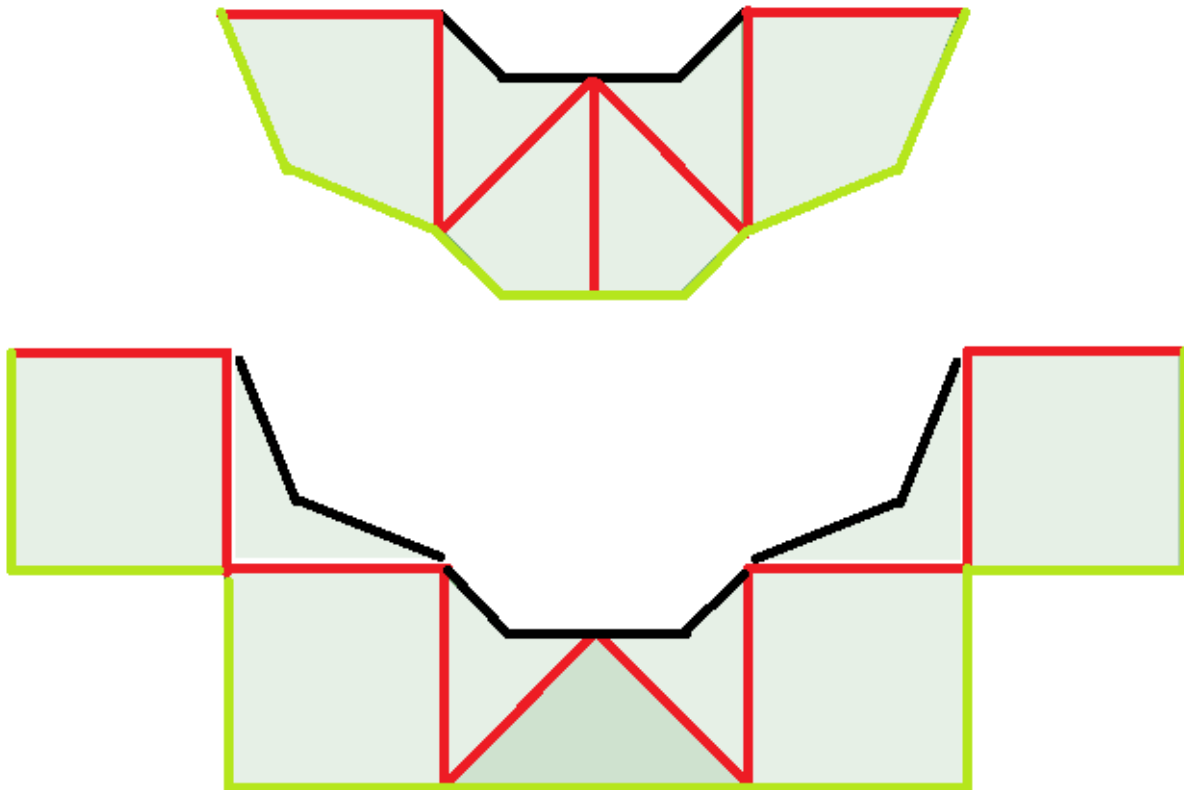
Building block 7 does not have a back wall but has two connectors for the building layer and also two connectors where the building layer above rests on.

More information is available at [http://www.fransvanschooten.nl/fvs\\_muqarnas\\_uk.htm](http://www.fransvanschooten.nl/fvs_muqarnas_uk.htm)

# Start

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Below you see a worksheet of a simple muqarnas consisting of two layers. The upper drawing concerns the upper building layer and the lower the lower building layer.



In the box is a large stock of 3D printed building blocks to make this design. Of course you're not going to try to put them together just like that. First you are going to investigate what is meant by this drawing. Read the assignments carefully. When you have time left, you may enjoy the challenging assignment of a muqarnas in Bursa, an important city in Turkey.

# Design rules

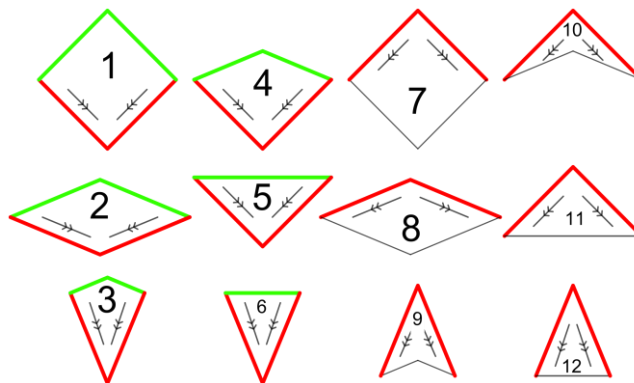
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There are three design rules. You should know that walls are colored green:

- Green of the upper layer may rest on black of the lower layer
- Green of the upper layer may rest on red of the lower layer
- When red is against red, arrows should point in the same direction

## Exercise 1:

Write the number of the shape in the drawing above for each building block..

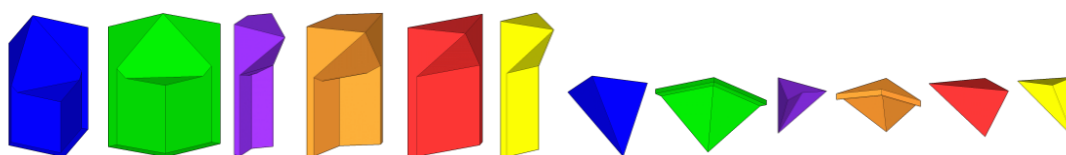


## Exercise 2:

Draw all the red arrows and check your design to meet the three design rules.

## Exercise 3:

Open the box with the 3D printed building blocks and find out which one belongs where.



## Exercise 4:

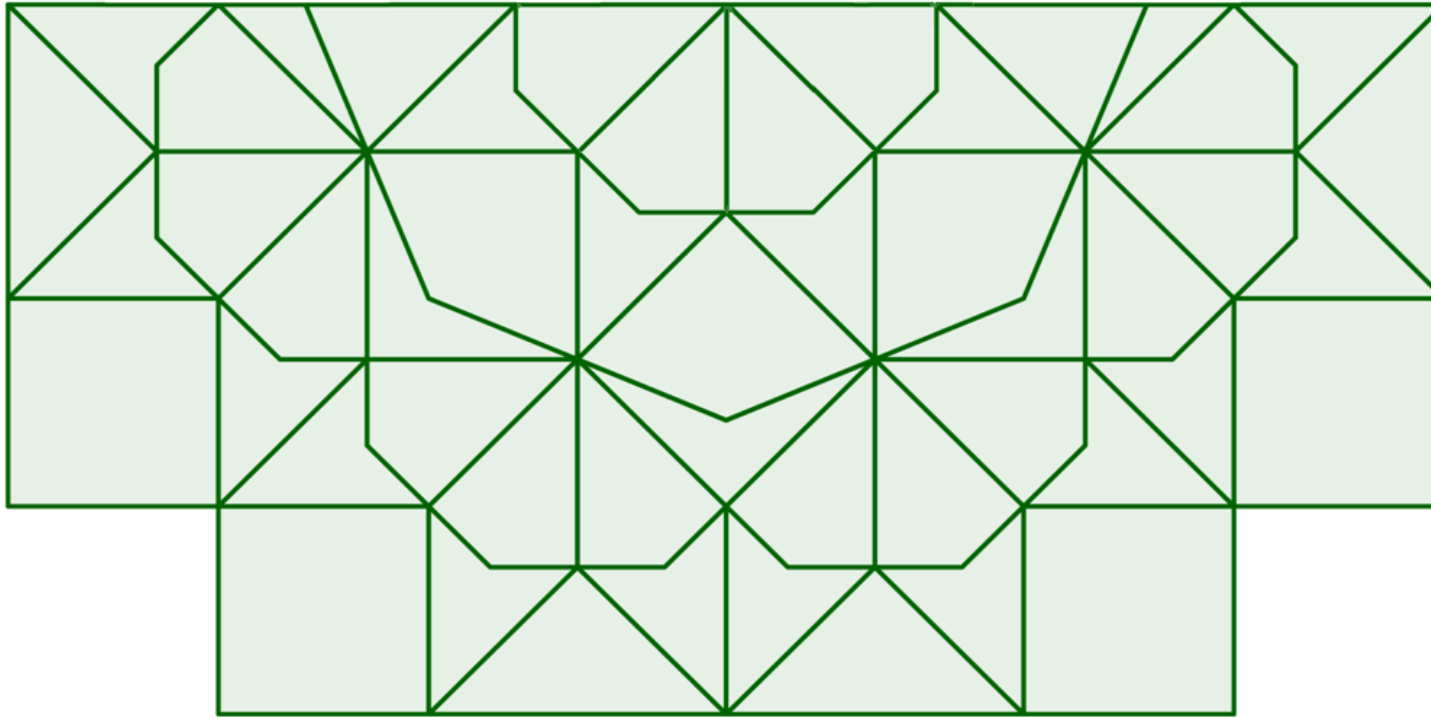
Position the 3D printed building blocks on the right spot in the construction plate.



When you are ready, check your results on the website  
<https://www.geogebra.org/m/tcmsgvjw#material/dyndw4jq>

# Bursa Abdal Mehmet Camii

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Search for the walls and color them green.

Draw the red arrows with their direction.

Give each building block the right number.

Produce the muqarnas on the construction plate.

When you are ready, check your result on the website <https://www.geogebra.org/m/tcmsgvjw#material/ncndjfp>

Exercise: