

Arabesques for Abu Dhabi

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The request of Foster+Partners, architects in charge of the development of the new Central Market in Abu Dhabi (UAE), was to design patterns for the screen system of the façade. As they wanted a "modern interpretation" of the traditional art, this request turned out to be a very interesting opportunity to experiment my ideas in real size.

According to physical constraints I chose to start from the isometric network of an Ammann pattern [9], which allows the design to be developed at different scales by self-similarity.

Then came the idea to use not one, but two complementary networks.

This overlapping of networks was very powerful in creating new shapes, which are nevertheless strongly anchored in traditional forms.

By the way, we met a new relation between traditional patterns and octagonal quasicrystals.

1. First stage: the “multi-network” background.

Initially, I had to find a network capable of fixing all the dimensions of the façade. Because of the strong orthogonality of the whole structure, I chose to work with an octagonal system. An inflation process (fig.1) enabled to fix short as well as long dimensions. However, I met with some difficulties in inserting the different heights of the screens in this system. This led to the idea of using not one, but two “complimentary” networks, each one with three levels of inflation development.

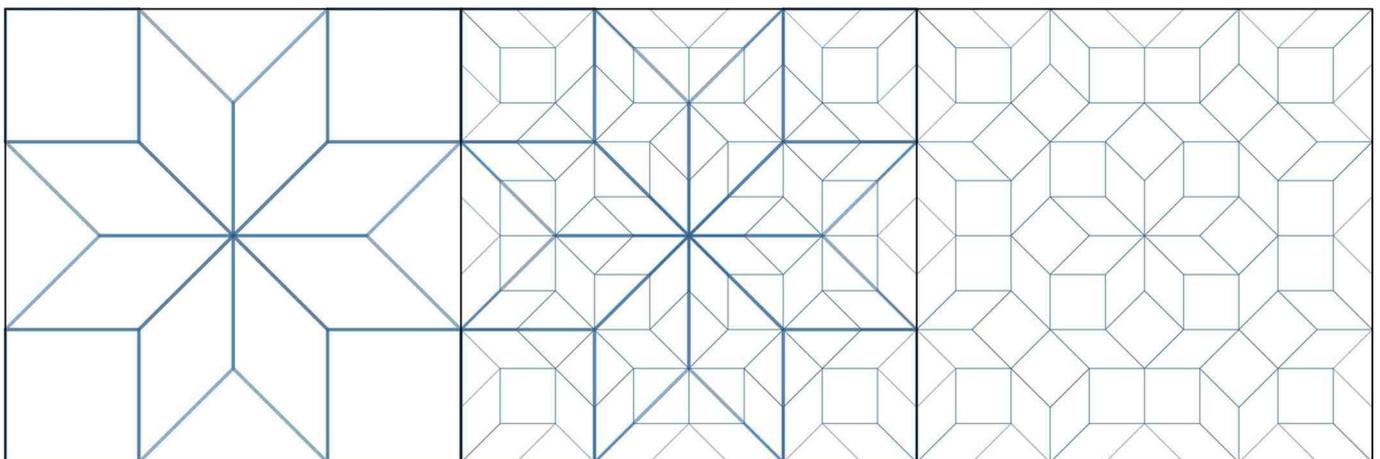


fig.1 : inflation development of the first network (A). Left : level A1. Middle : transformation rules for squares and diamonds. Right : level A2.

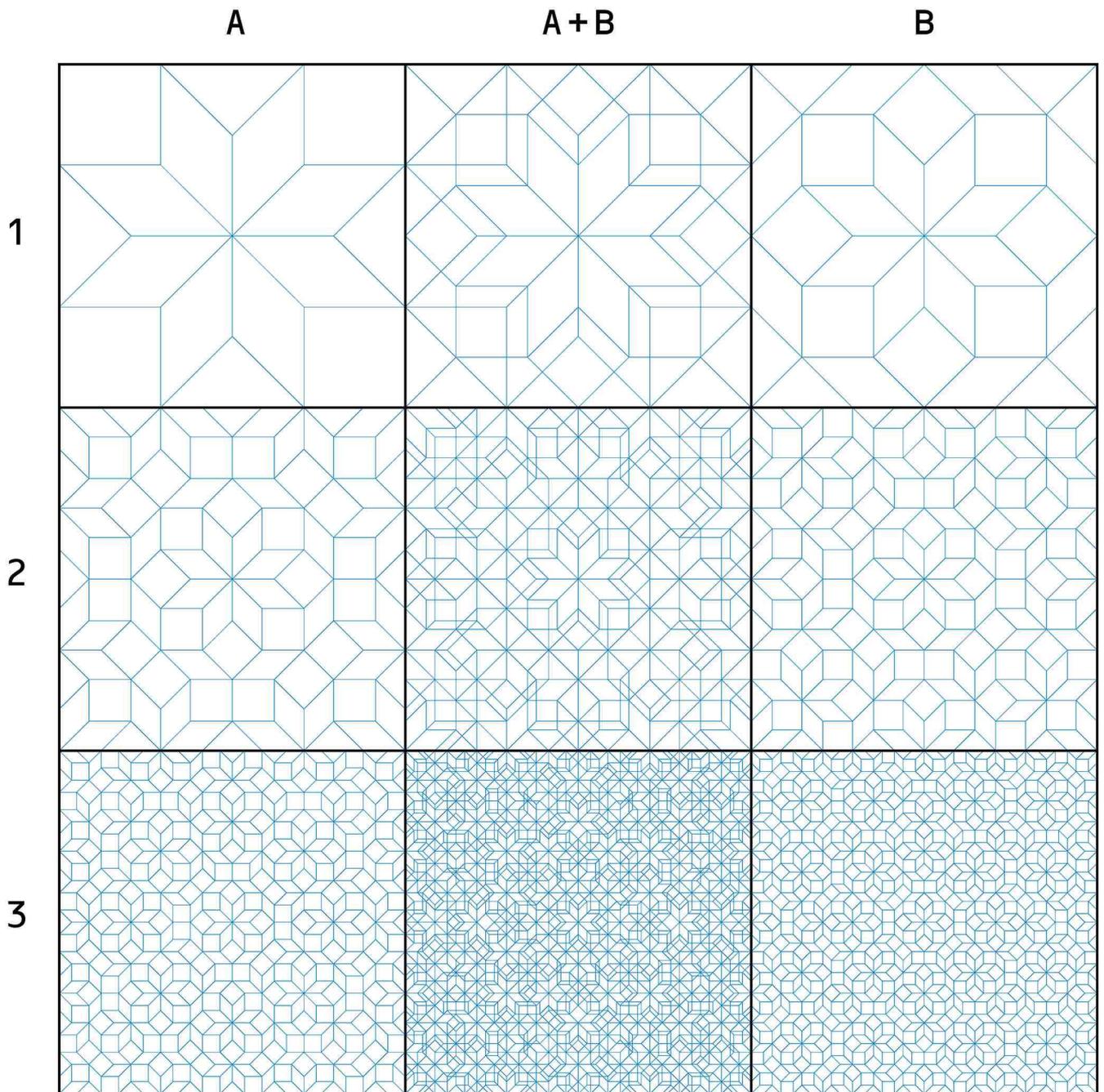


fig.2 : the multinetwork system. Left : first network, its 3 levels of development. Right : same thing for the second network. Middle : the 2 networks overlapping.

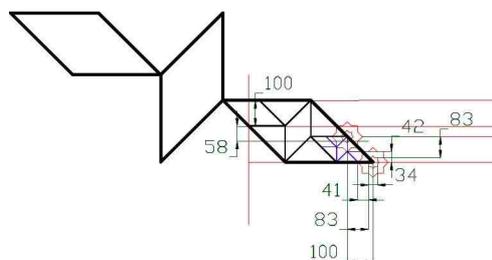


Fig. 3 : System regulation for every dimensions of the façade.

From this “multi-network” we developed a system for regulating all dimensions, from the smallest to the largest (fig. 3). The main unit was divided into three adjacent panels of two different widths (fig.4). The resulting units existed at three different heights (5,5m, 7,5m and 8m).

Then (Fig. 5) the network was used as a grid for drawing the various patterns, with different scales available (this part of the work began with free-hand drawings) The shapes come from the traditional world of zellij (mosaic made of ceramic). By the way, this demonstrate a new link between quasi-crystals and traditional patterns.

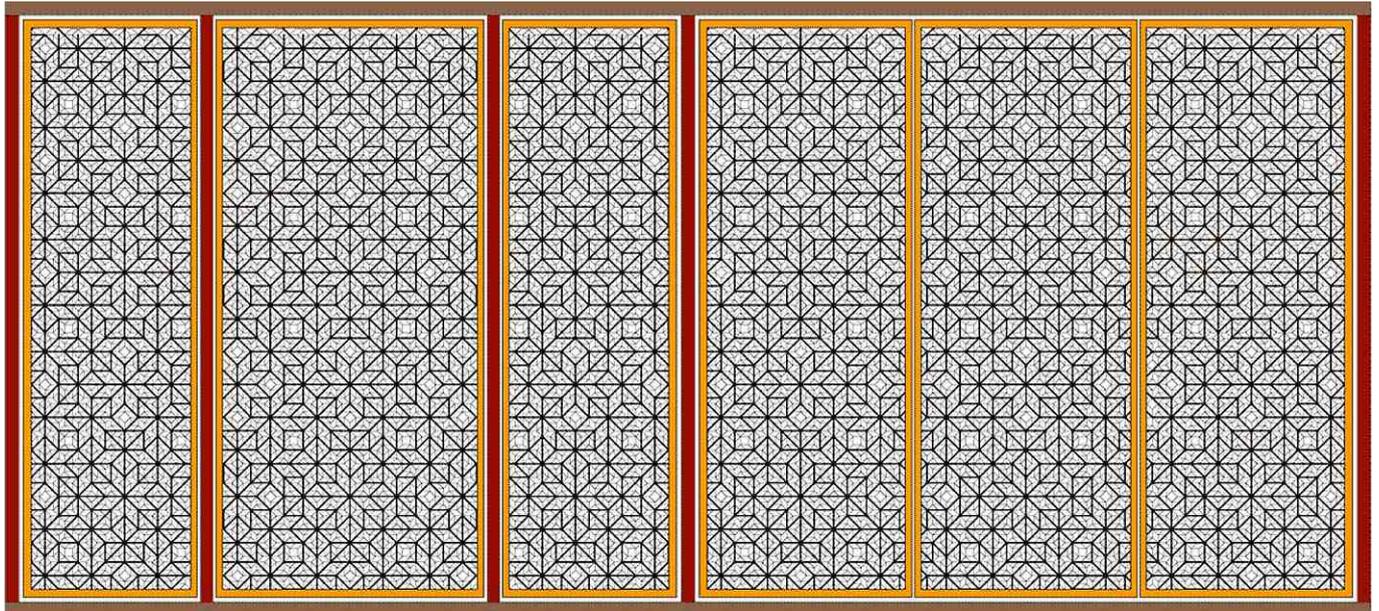


Fig. 4 : implementation of the multinetwork in the main unit of 3 screens, with posts in between (left) or not (right).

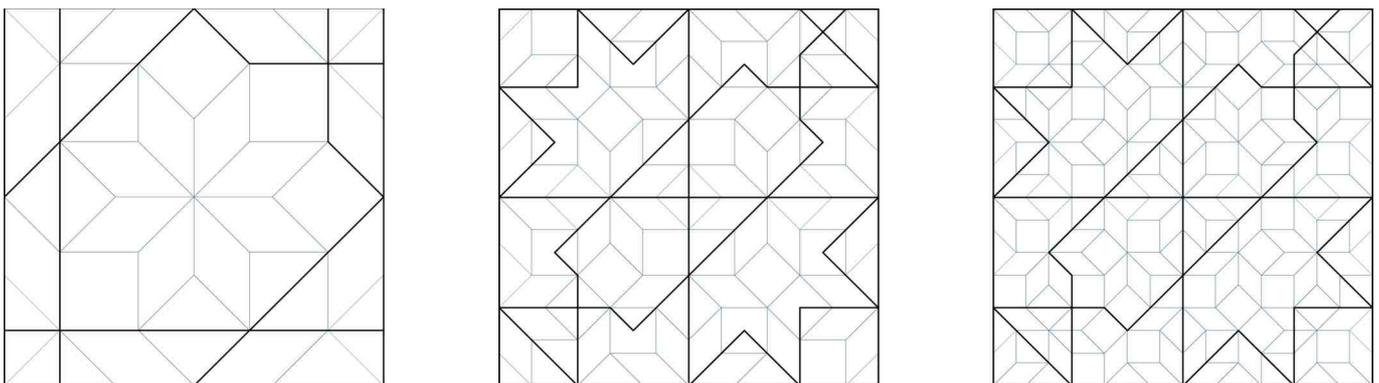


Fig. 5 : the network as a grid from which can be drawn standard zellij tiles. Left : level A2 (according to fig.2 code). Middle and right : the same pattern drawn on level A2 and on level B2.

2. Second stage.

After some changes in the dimensions, the division of the main panel ended up being of equal width (2,8m) . The new option is that most of the screens will be very simple and the others, scattered within the façade, will belong to two families: low complexity (“active screens”), and high complexity (“hyperactives screens”) at the entrances. The doors also needed to be in the “modern Islamic style”.

Active screens patterns are drawn from one of the available levels of the multinetwork. They looked like details of a hidden large drawing, which is possible as long as they are never adjacent.

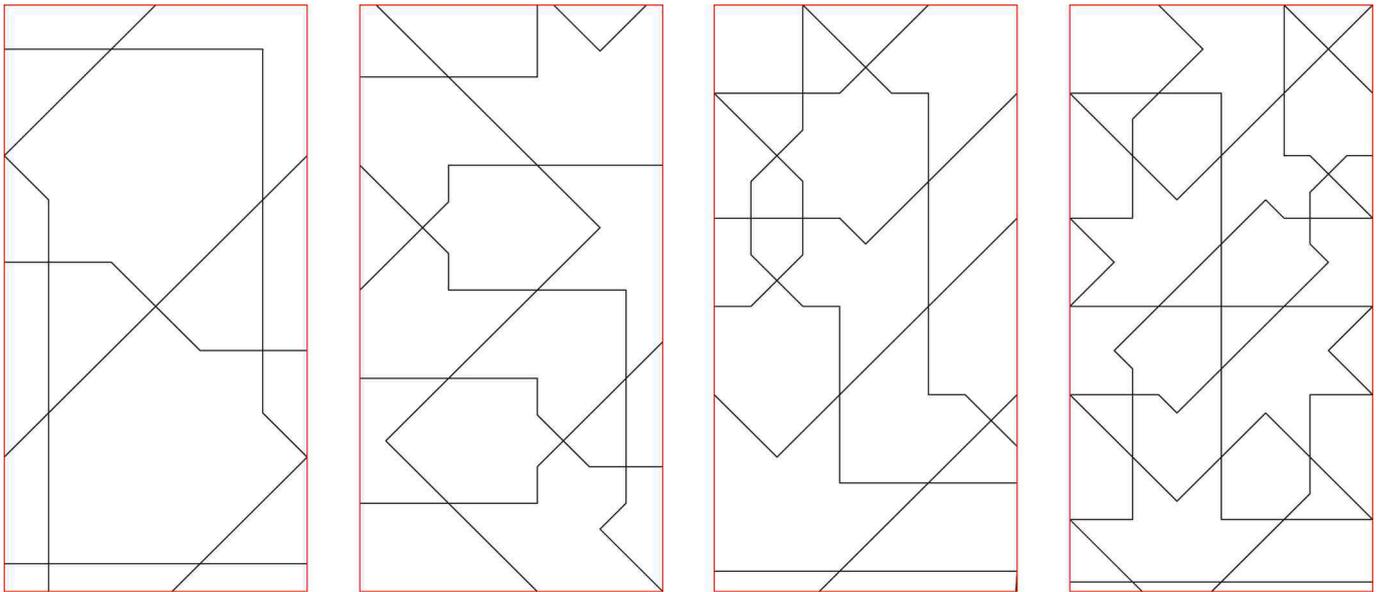


Fig. 6 : “active screens” drawn on levels B1, A3, A3 and A2 (5,5m high).

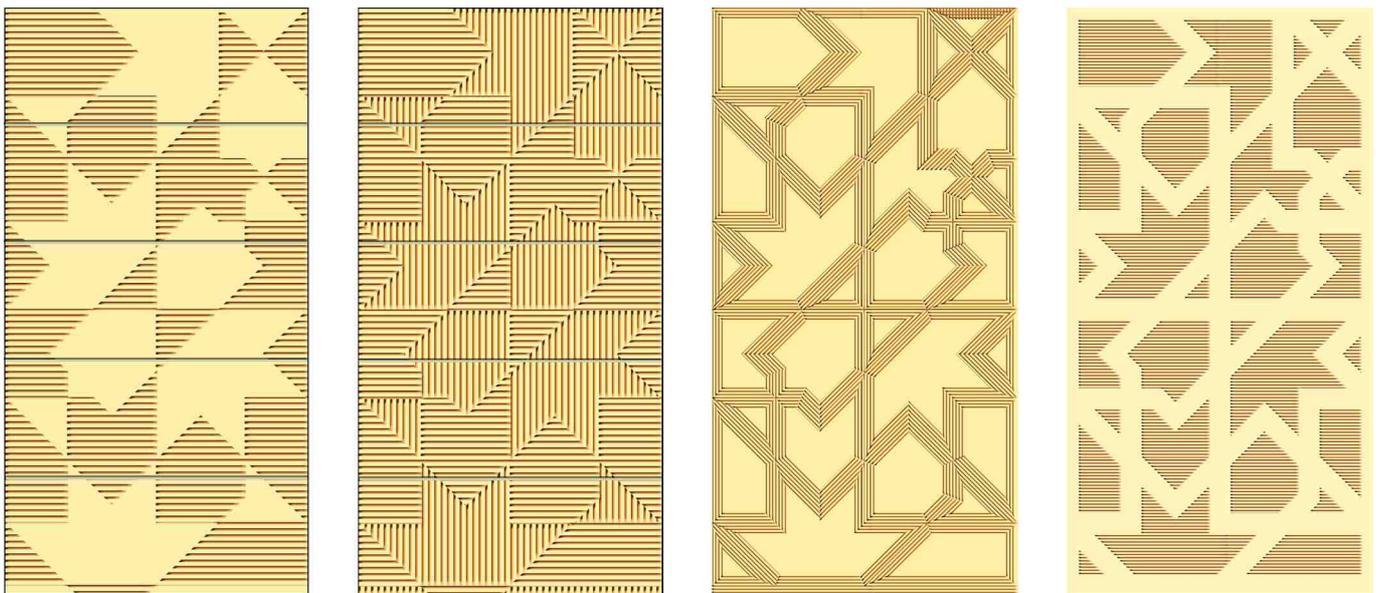


Fig. 7: “active screens”, possible material interpretation in terracotta. The screens for the interior façades will be made of timber.

3. “Hyperactive screens”.

The same process was used to create those more complex patterns. They had to be colored, to use transparent materials, and to be placed as “hot spots” above the entrances of the building.

Constraints: the patterns had to fit in the 3 different heights. The multi-network system makes this possible. Then, two of them had to be superimposed and must fit in continuity.

In fig. 8, the first pattern (left) uses 2 scales: a zellij-like pattern, and a background made of squares and rhombus. The second (middle) uses 2 scales of zellij-like tiles, superimposed. So here we have three levels of seeing. A long distance pattern, a short distance one, and a background filled with squares and rhombus. The last panel (right) is a direct consequence of the multi-network (levels A3+B3). It is an absolutely new pattern though it belongs to the Islamic style.

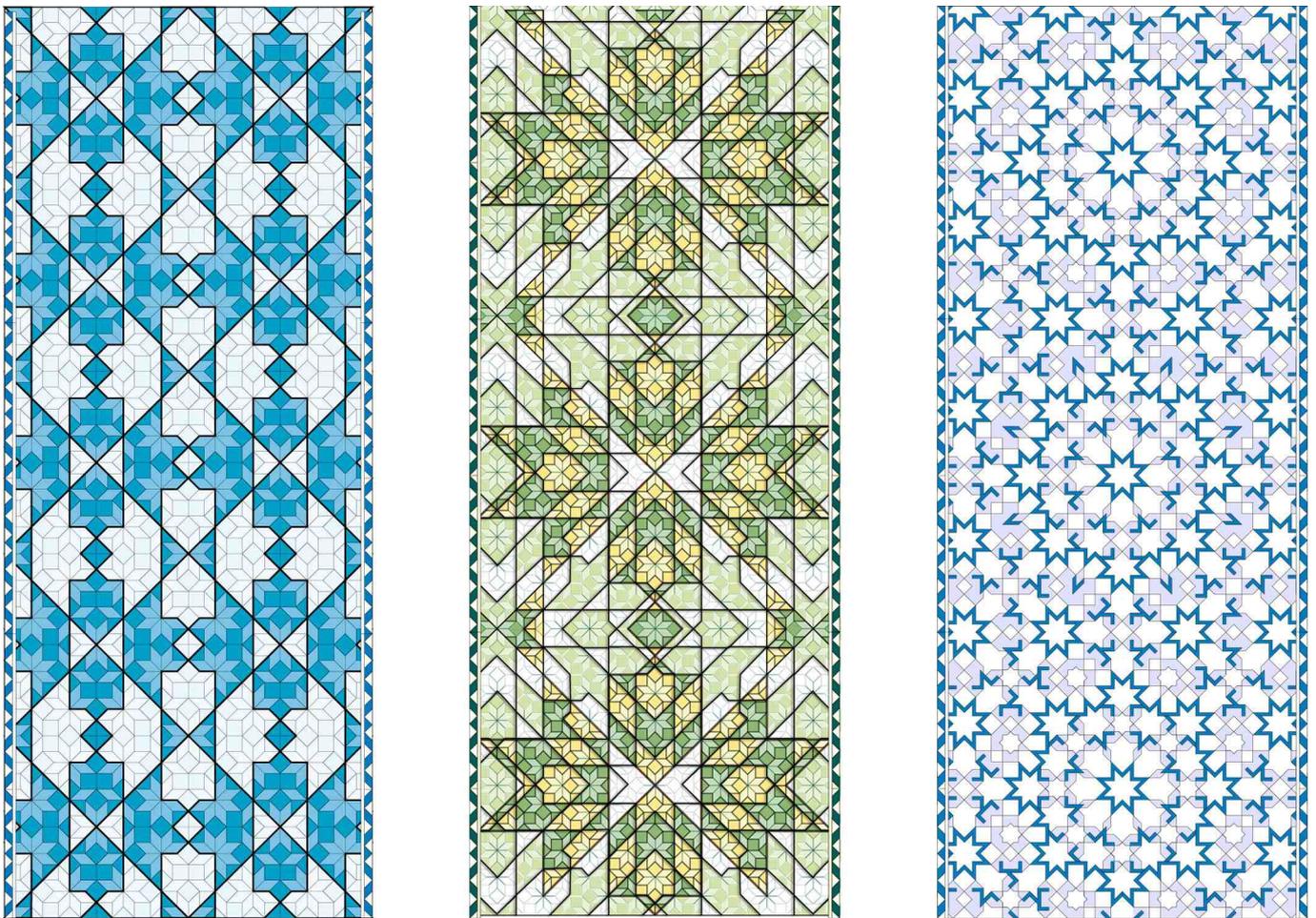


Fig. 8: “hyperactive” screens (8m. high).

4. The doors.

Once again we are using the same multinet network system for the doors.

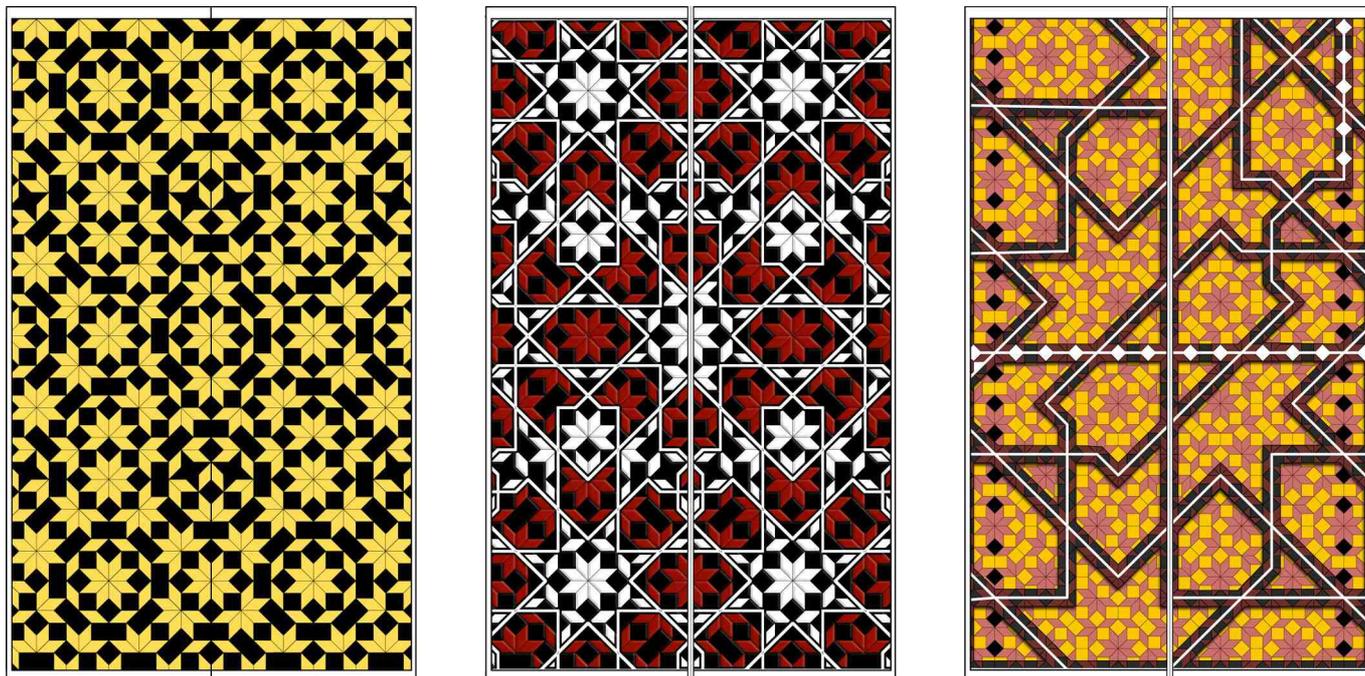


Fig. 9: 3 models for the 5,5m door. Left and middle : level A3. Right : level B3.

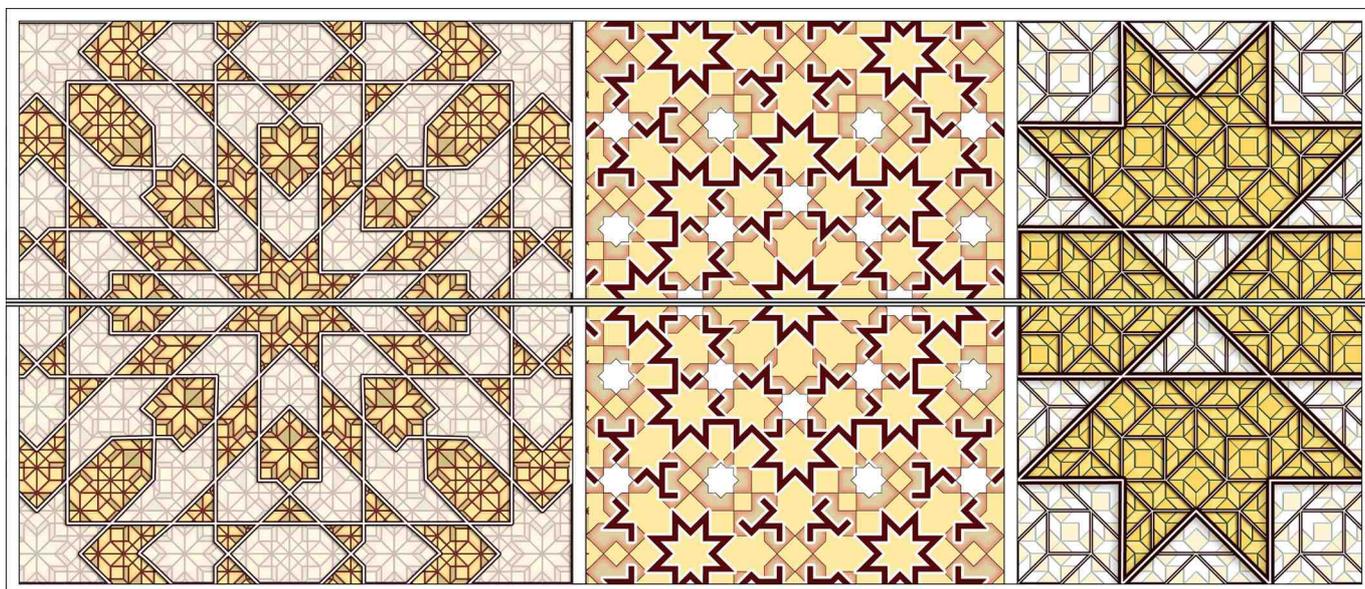


Fig. 10: 3 models for the 7,5m door (rotate of 90°). The 3 parts are drawn on the same hidden background (level A3+B3).

5. Making.

A lot of changes occurred along the adventure of this project, which is still in progress.

Unfortunately not all the options I've imagined will be realized. The limitations are mainly due to economic constraints, and difficulties in making.

Along the process came the necessity to fix the width of the interlaces for the “hyperactive screens” (which have changed from fig.6 proposal to other drawings derived from the “active screen” patterns.

Finally I fixed this size according to a smaller network level (A4).

This gives another link between traditional patterns and octagonal quasicrystals.

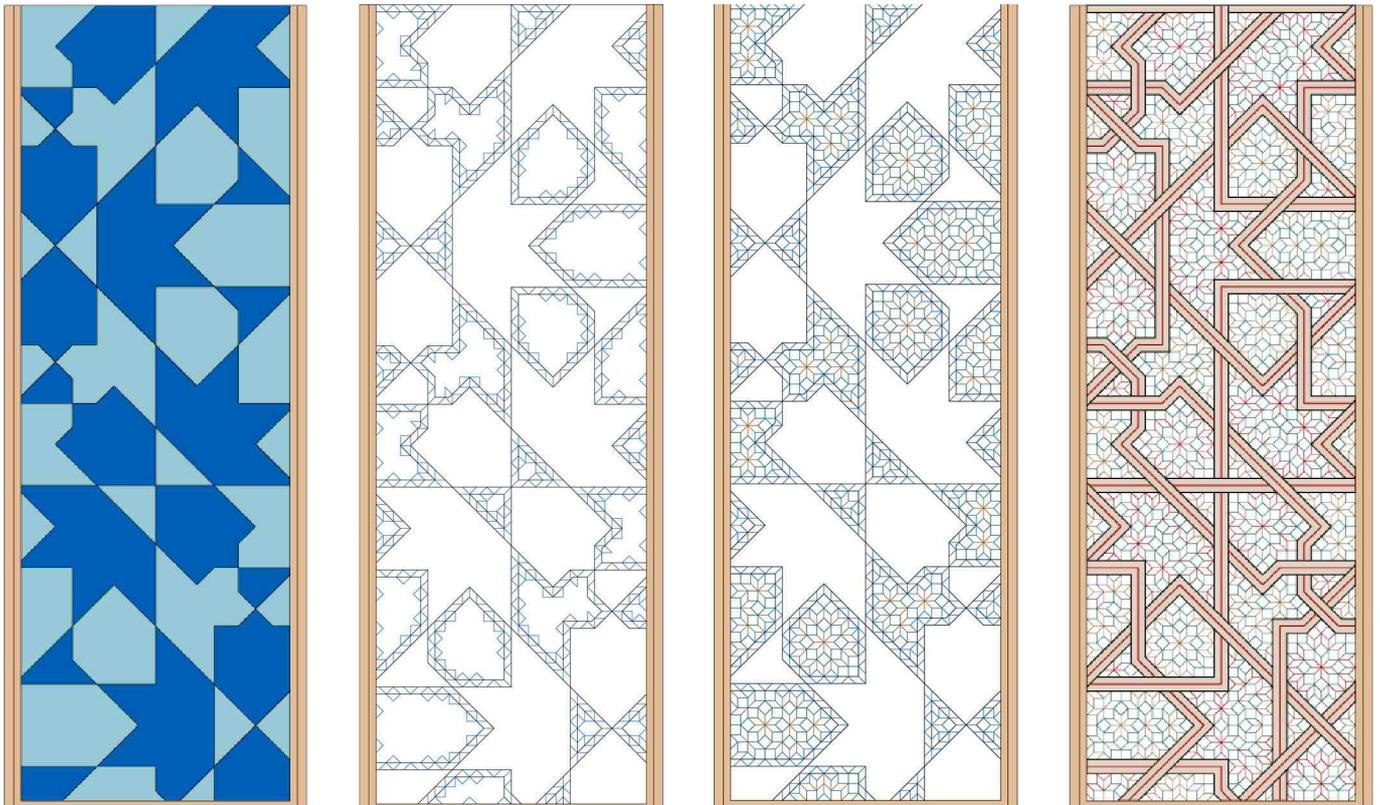


Fig. 11 : The simple pattern ; half interlaces filled with squares/rhombus ; Half of the tiles ; final pattern with interlaces.

6. Conclusions : new connections between octagonal quasicrystals and traditional Islamic patterns.

1. In previous publications [2], [4], [5], I demonstrate a link between the hidden structure of the octagonal family of zellij patterns, specially in the Arabo-Andalous style, where the “skeleton” of the pattern is drawn on the lines of a square/rhombus grid that can be considered as a part of an octagonal quasicrystal (call it Q1, fig.12).
2. Working with the networks for the Abu Dhabi Central Market project demonstrate another level of link : not only the skeleton but the tiles themselves are drawn on the lines of another quasicrystal, Q2, which scale is smaller than the one of Q1.
3. When using interlaces embellishment of the patterns we introduce another quasicrystalline structure, Q3, with smaller scale than Q3.
4. I previously established a connection between zellij patterns, quasicrystals and muqarnas structures [2] by the link of skeletons (Q1). Now we also have such a connection with the Q2 and Q3 system.

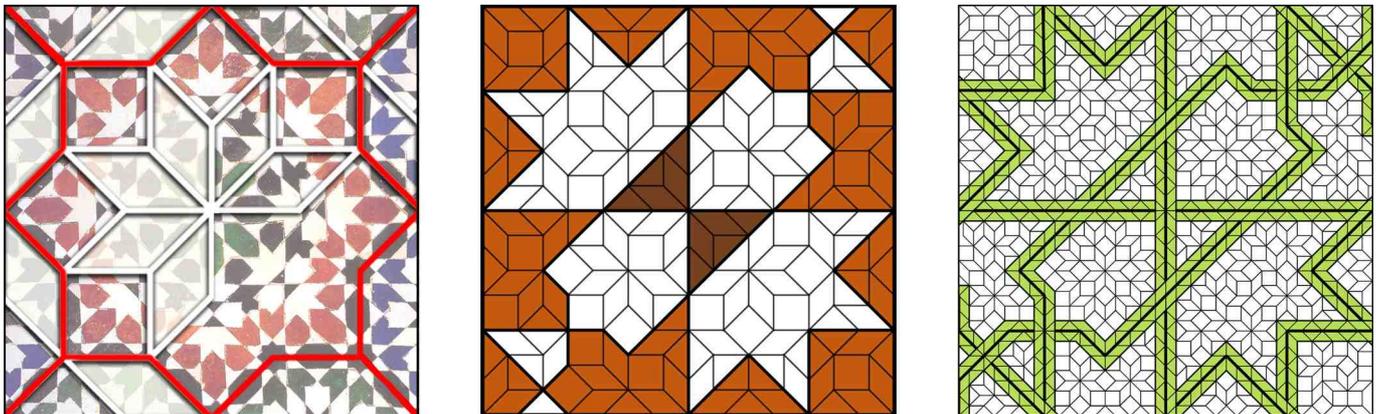


Fig. 12 : skeleton level, quasicrystal Q1 ; tiles leves, quasicrystal Q2 ; interlaces level, quasicrystal Q3.

Finally, to the question “is there a connection between traditional Islamic patterns and quasicrystals, and where ? “ we can answer : Yes, everywhere between the octagonal family and octagonal quasicrystals (but not necessary in a perfect way) !

References

There is a lot of publications on the link between Islamic art and pentagonal quasicrystals (or Penrose patterns), but not so much on the link with octagonal quasicrystals (or Ammann patterns).

[1] : Jay Bonner, 2003, “Three traditions of self-similarity in fourteenth and fifteenth century islamic geometric ornament”, *Meeting Alhambra, Proc. ISAMA-Bridges 2003*, p. 1--12.

[2] : Castera, 2003, “Play with infinity”, *Meeting Alhambra, Proc. ISAMA-Bridges 2003*, p. 189--196.

- [3] : Castera, 2002, "Regards sur l'Arabesque", *Pour la Science* n° 299 Septembre 2002 , p.104-105.
- [4] : Castera, 1999, "Zellij, muqarnas and quasicrystals", *Proc. ISAMA 1999*, pp. 99-104.
- [5] : JM. Castera, H.Jolis, 1992, *Géométrie douce*, éditions 6^{1/2}, Paris.
- [6] : B.Grünbaum and G. C. Shephard: *Tilings and Patterns* (Freeman, New York, 1986).
- [7] : E. Makovicky, F. Rull Pérez and P. Fenoll Hach-Alí, 1992, *Mirador de Lindaraja: Islamic ornamental patterns based on octagonal lattice in Alhambra, Granada, and Alcazar, Sevilla, Spain*, *Boletín Sociedad Española Mineralogía* 19 (1986), 1-26.
- [8] : Senechal, Marjorie, "The Mysterious Mr. Ammann", *The Mathematical Intelligencer*, 26:4 (2004).