LUIS ALFONSO DE LA FUENTE SUAREZ

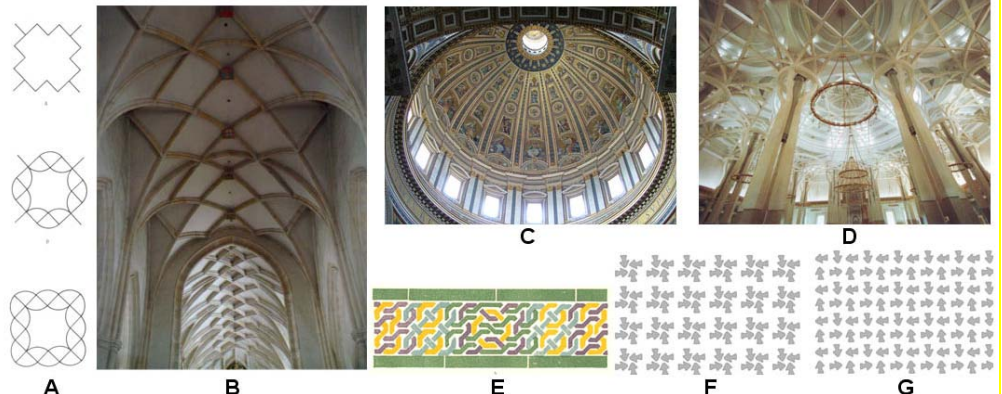*Paper: **Architectural Complexity: Hiding the Underlying Order***

Topic: Architecture

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Abstract:
We see buildings but, do we understand their geometry? This paper is a perceptual approach to the comprehension of architectural composition. As we know, Gestalt Psychology is concerned with the principle of simplicity in our perception, understanding by this the way simple patterns are "easier to see" because we are inherently predisposed to find them. Gestalt principles tell us the characteristics that a figure or group of figures should have to be considered simple: continuity, closure, similarity, proximity, etc. We compose our visual world of the simple elements we find in it. Every shape would in theory be reduced to simple collections of interconnected shapes. But, while simple things are easily visible, and therefore easily comprehensible, there are some kinds of patterns, the complex ones, which are difficult to see and to comprehend. We will focus on those designs that evade to be simplified and that does not allow us to use the Gestalt laws that help us in perceiving normal objects, therefore making us difficult the creation of a mental idea of their composition. This paper is about complexity of conception and difficulty of perception. We will focus on the ways we can "hide" or take out of view the ordering principles of architectural shapes. All ordered structures are susceptible of complication, and in architectural compositions ornament has an important role.

A,B.- The *masking of a shape* is the addition of figures or lines to a basic configuration causing it to be less evident, in some cases turning the original shape impossible to find. **C.-** The *clear differentiation of the iterated pieces* in St. Peter's Dome is an aid in understanding the whole. **D.-** As in Islamic patterns, in the Rome Mosque the continuity and ramifications of the linear pieces makes an *entanglement that escapes from our view* and mind. **E.-** The fact that each piece has a different colour makes this Moresque frieze less complex, because each component is *easier to see*. **F,G.-** Disobeying the *grouping by proximity principle* makes the order of the composition in G more difficult to see, even though the underlying order is the same as in F.

Keywords:
Architecture, Complexity, Perception, Gestalt, Order, Geometry.

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Architectural Complexity: Hiding the Underlying Order

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Abstract

We see buildings but, do we understand their geometry? This paper is a perceptual approach to the comprehension of architectural composition. As we know, Gestalt psychology is concerned with the principle of simplicity in our perception, understanding by this the way simple patterns are "easier to see" because we are inherently predisposed to find them. Gestalt principles tell us the characteristics that a figure or group of figures should have to be considered simple: continuity, closure, similarity, proximity, etc. We compose our visual world of the simple elements we find in it. Every shape would in theory be reduced to simple collections of interconnected shapes. But, while simple things are easily visible, and therefore easily comprehensible, there are some kinds of patterns, the complex ones, which are difficult to see and to comprehend. We will focus on those designs that evade to be simplified and that does not allow us to use the Gestalt laws that help us in perceiving normal objects, therefore making us difficult the creation of a mental idea of their composition. This paper is about complexity of conception and difficulty of perception. We will focus on the ways we can "hide" the ordering principles of architectural shapes. All ordered structures are susceptible of complication, and in architectural compositions ornament has an important role.

1. Simplicity and our mental description of things

Through visual perception we organize and localize objects in space, we do this by making hypotheses based on the information we receive through our eyes. These Hypotheses are the simplest possible interpretations of the retinal images, as Gestalt psychology state.

We can easily see figures above a ground, see depth in our three-dimensional world, or group similar o nearby figures. Nevertheless our process of interpretation of shapes does not finish there; we can also hypothesize about the ordering principle of the objects we see. Going up to a higher cognitive level we are able to understand shapes as extrusions, revolution surfaces or as patterns made by connecting different pieces in space. We are not talking about perception but the construction of a mental idea, a description or conception based on the objects that we see. To conceive is to comprehend the shapes, to understand how they have been created, and in the case of ordered structures, it is about understanding the restrictive

processes that created them. We can only describe order and our mental idea of the objects and buildings is always based in what we consider ordered in them. [22]

We can see clearly a sphere, its regular curvature, closure, continuity and symmetry, but we can also think about it as a surface whose points are all equidistant from a central point that we cannot see, or as a revolution surface created by rotating a circle with a diameter as axis.

Objects evoke in the observer's mind a mental idea of its shape, and it is usually the simplest interpretation of that shape the one we prefer, that is why it is called *minimum descriptive* [20]. We can interpret a cylinder as a line rotated around an axis or as a circle being translated through a linear path. Every object may have a lot of different descriptions but the most of the times only one can be considered the simplest or easiest way to explain its shape.

1.-There are two possible interpretations of this pattern, the first is the revolution of a curve around a circle and the second is a description where the horizontal section of the object is variable. Because of its regularity the first option is the simplest and the one we use as a description of the object. [20]

2.-By showing and making visible some "conceptual" lines we can induce a certain interpretation of a shape. In the Reichstag we find meridian lines that can make us interpret the shape as a revolution one, but also there are parallel circles that we can use for constructing this dome as a sequence of sections diminishing in size.

2. Geometric order in architectural shapes

Structure is the principle governing the configuration of an object. When we talk about geometrical structures is because we are considering measure restrictions as important. Linear or radial configurations, polyhedra, and two or three-dimensional lattices are the basic structures we can find.

The complexity of any geometrical structure depends on the series of steps we need to mentally describe it. Complexity is not a property of the objects but the difficulty that we experiment in trying to understand them. Some qualities of a building shape can help us in selecting an easy to understand description of that building, or by the contrary a more complex one. Our mental idea of a shape can vary radically depending on the structural elements that compose it, or ought to secondary elements as ornament.

3,4.-A one-sheet rotational hyperboloid can be described as a revolution surface resulting of the rotation of a parabola, but also as the net of connecting lines from two circles rotated respect each other [25]. As opposed to the James S. McDonnell Planetarium, the tower constructed by Vladimir Shújov shows us those connecting lines and induces us to make a more complex interpretation of the hyperboloid. The lines are taking us by the difficult way in our route to comprehend the tower geometry; we make one interpretation that needs more spatial visualization skills than the other one.
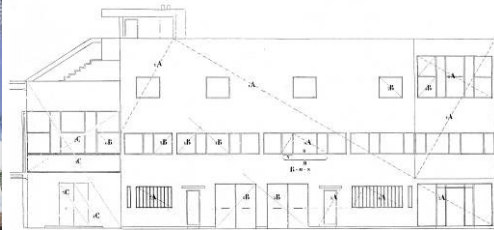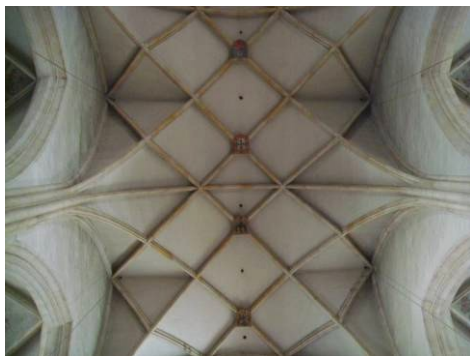
5.-A vault as the result of an intersection of volumes may be understood as simple, but in this case the addition of some ribs shows the diagonal connections between a column of an arch and the keystone of another. Those lines make explicit the exactitude and restrictions present in this particular configuration, and make it more structured and complex. *Graz cathedral*.

6.-When a pattern interacts with the global configuration it ceases to be an addition to the surface to become an important part of the description of the object. *Hearst Tower*, New York, by Foster + Partners.

7.-In our construction of a mental idea of a building its ordered restrictions do not exist for us unless they are perceptible. Le Corbusier tried in vain to create ordered configurations by using invisible conceptual lines that are not structuring anything. *Maison La Roche-Jeanneret*, Paris.

3. Making order explicit

In ordered compositions we can see some regular characteristics like iteration or symmetry, but in a random pattern we do not find many restrictions and do not spend much time in looking for them if they are hidden and not clearly visible. We know that

ordered shapes have many things to explore and connect; meanwhile we put random shapes in the category of *not having structure* or that one of *object without any principle to understand*. Maybe we do so unfairly.

8.-Certain elements can have an easily visible order e.g. sequences of objects in a linear or circular arrangement being grouped by its similarity and proximity. *Basilica di Santa Maria Maggiore*, Rome.

9,10.-When the structure is not that precise its order is not as easily visible unless it is explicitly signalled. We can see the configuration in this lotus flower as two groups of dots forming concentric circles; then it is a simple and a little bit random composition. But by drawing certain connections we can make explicit the ordering principle.

In some ordered structures an apparent randomness is achieved when the repeated unit has been rotated. We do not easily see two rotated units as the same figure as we do with translated or symmetric copies. That is why we lose sight of the order in certain structures.
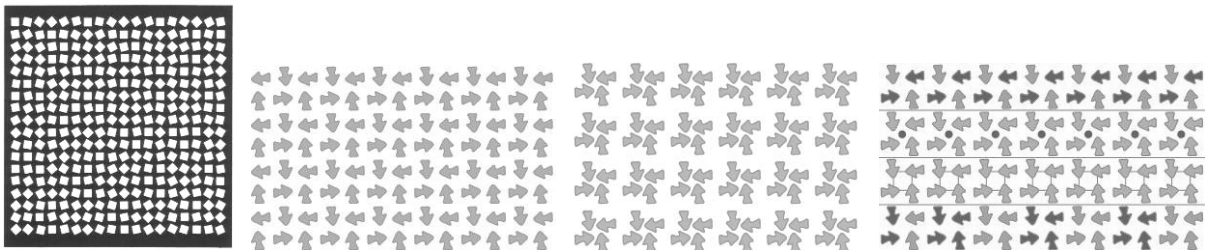
11.-Ought to the unstable grouping of figures we see this configuration as disordered in spite of the fact that we can easily understand the regular rotation of each square with respect the former and the following. Leonard Kitts Design.

12,13,14.-Depending on the separation of the repeated and rotated figure, a W4 pattern may seem disordered unless we group the figures by proximity, similarity of colour, by marking the centre of the rotation or by connecting the figures with lines.

The ordering principle that is not clearly perceptible or marked in the pattern has to be mentally separated, visualized of completed if we want to understand the structure. The patterns that need us to visualize require more effort to be understood and therefore we can say that they are more complex.

15,16.-Irregular polygon tessellations are apparently imperfect because of its rotations and the differences in length of the repeated figure sides. By creating structured compositions with the pieces of a similar pattern we may make it look ordered. The *Melbourne Recital Centre*, by ARM, and the *Ravensbourne College of Design and Communication*, London, FOA.

17.-A series of three-dimensional objects being rotated in an ordered manner can also seem disordered from certain points of view. This happens unless we surpass randomness by turning the hidden order visible as in this tensegrity by Prof. Neukirch.

4. Masking and hiding the original order

Enriched configurations with framed parts full of details are not a problem for our order understanding, because clear separation of parts helps us in this process. But sometimes the addition of details to an ordered structure hides or masks that original structure. The figures have been visually destroyed and reincorporated to different groups or configurations. [17]

18.-In the *Stephansdom* of Vienna the global shape has subdivisions that are also subdivided. Every element is clearly seen as pertaining to a part in the bigger whole, a property that simplifies the composition despite its infinity of details. The tracery inside an arch does not make difficult for us to see the limits of the arch, then there is nothing masked in this composition. We can call to this enrichment and detailing of the different parts of a building a *clearly distinguishable profusion*. The artisans love for Infinite details does not necessarily result in a complex composition.
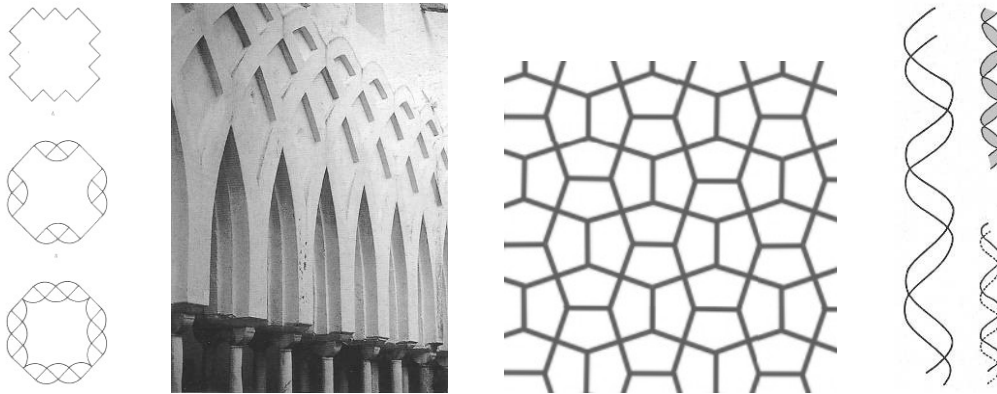
19.-In these configurations the added figures does not help us in recovering the original figure from the new pattern. Now it is almost impossible to see it as a whole piece or figure.

20.-The masking of repeated elements by their superposition makes every piece difficult to distinguish as a separated element. The organization behind this structure is simple, but the perception as figures of the units that better help to explain that organization is not that evident. *Cloister of the cathedral in Amalfi*.

21.-Here we can still see the two hexagonal grids that are superposed; then they are not hidden. By painting each grid in a different colour we would have even less difficulties in separating the two layers.

22.-We see this configuration as two superposed but continuous undulated lines, but by colouring the inner space between lines the closed figures gain in importance and become the explaining unit of the whole. By hiding the simple undulated lines we have created a frieze made of symmetrically repeated pieces.
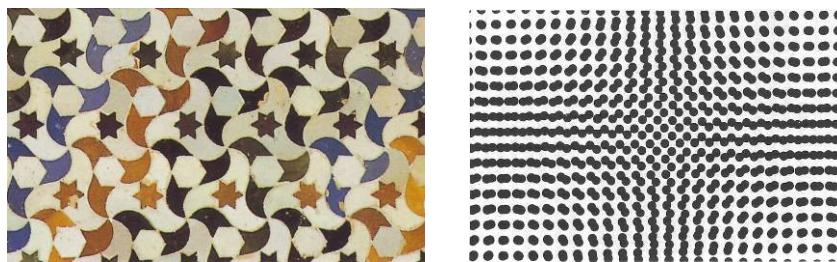

23.-Far from allowing us to see the three patterns of undulating lines which are superposed, this pattern with its added stars and its mosaics with different colours make us see as figures the resulting spaces between the original undulated lines, while these lines disappear from sight. By masking the original explanatory lines the composition has become more complex; the coloured figures with which we now compose a mental pattern vary in shape and orientation. Mosaics in the *Court of the Myrtles in the Alhambra* of Granada.

24.-Moiré patterns are created by superposing two simple patterns that in the final product are not longer visible separately. The more complex resulting configuration is composed of sequences of ordered variations in the positions of two circles. In this subtle kind of complexity and in all complex patterns in general, the whole is more difficult to see and understand than the sum of its parts.

Taking the concept of masking to a three-dimensional level, we can hide an object by adding other shapes to the original object or by repeating it in space creating a lattice.
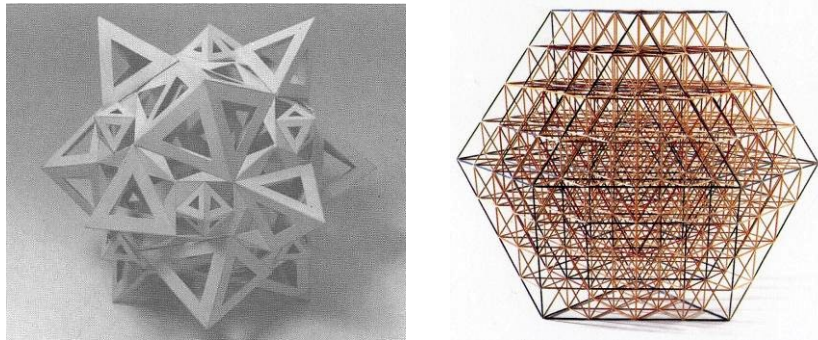

25.-A masked great rhombicosidodecahedron with added tetrahedrons and quadrangular pyramids.

26.-In three-dimensional lattices it is easy to lose sight of the repeated spatial cells. This is caused by the masking of the cell edges by multiple components of other cells. Not being allowed to see the cells we cannot make a clear idea of the configuration as a whole. Lattice model by Buckminster Fuller.

5. Masking and the disappearance of the limits between patterns

In some geometric structures like square grids we may find rectilinearity, parallelism, symmetry, and repetition; we see these characteristics clearly thanks to the groupings of squares forming linear rows and columns. In complex patterns the figures and their groupings are visually unstable; the groupings of figures we can see are always changing and none of them is very helpful in understanding the whole composition.
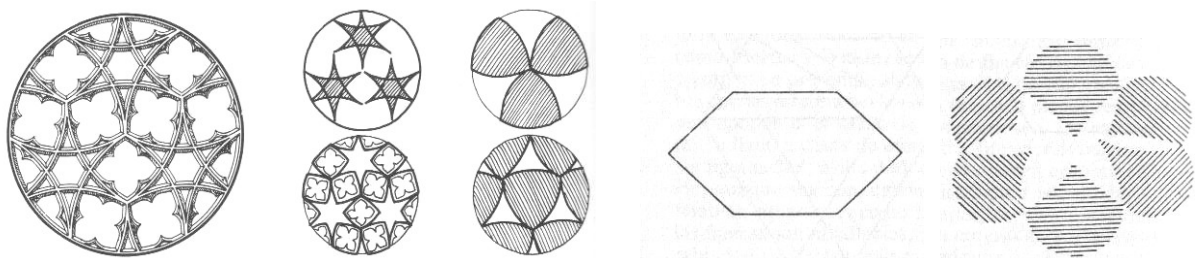

27.-The subdivisions in a gothic tracery can be grouped inside several groups and create different figures. We can see the tracery as a circle with tree stars, a circle with three triangles, twelve quatrefoils, etc. This example is unstable but its figures are not hidden; we can still see every subdivision of the circle. [14]

28.-The hexagon is not visible anymore because its edges have been grouped in a pattern of lines [17]. By making disappear the hexagon, this configuration has gone beyond perceptual masking, but it is still easy to understand.

By fusing coordinated patterns in a way that the pass from one to the other is not perceptible we can create a complex structure. The limits between them are masked with the pieces that surround them. In these cases when the original patterns are masked or hidden and its boundaries are diffuse we look incessantly for a way of dividing the pattern in groups of elements.
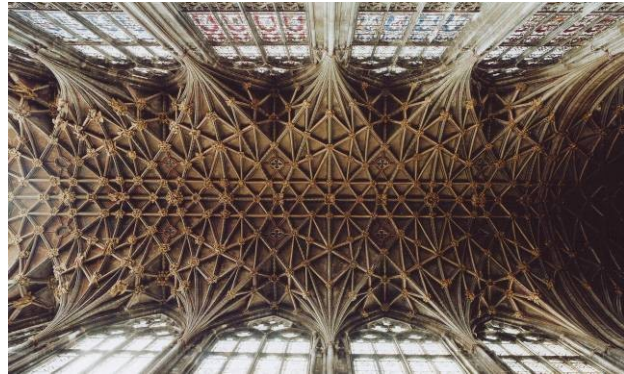
29.-The polyhedra that served as a base to this geodesic dome is so masked that possibly we are not aware of the hidden icosahedron. The pattern inside the faces of this polyhedron is a simple configuration of triangles which are integrated with the little triangles of the next triangular face; therefore the dividing edges between faces are lost. *AT&T Pavilion* by Buckminster Fuller.

30.-The subdivision in triangles of this vault is not as regular as that in the previous example. Furthermore the principal structure of lines is not as well masked as it is in the dome. *Gloucester Cathedral*.
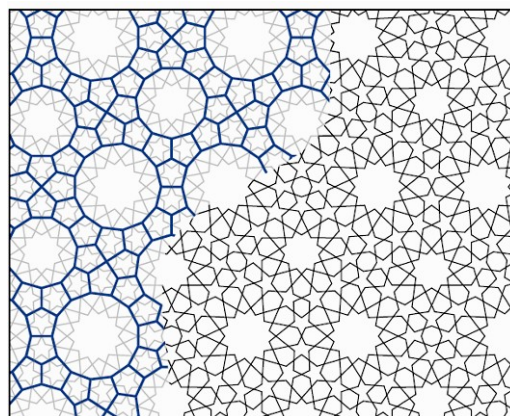

31.-By superposing onto the star pattern the original mosaic where it was originally drawn we radically simplify the geometric composition; the lines of the stars do not continue indefinitely and the pattern becomes visually more stable. In this pattern the original structure had not been masked but erased. Therefore we can prove that complexity is independent of the amount of elements present in a composition, because if we add elements that help us in understanding the structure, we are increasing the amount of details while reducing the complexity of the pattern.

## 6. Interlace: lines that escape from our sight and mind

In interlace patterns the lines that usually just divide figures are transformed into linear material objects. When we say that interlace patterns are one of the most complex configurations possible is because we are considering the complexity we would experience in trying to follow the laces; when we analyse how each lace is woven in relation to the others.

Possibly the function of ornament is not necessarily to be an object of our attention and analysis, but an object just to be seen [14]. But perhaps it is not that they do not deserve our attention but that they do not leave us to get deep in the comprehension of their inherent structure. For complexity to be encountered it is of extreme importance the disposition of the observers to go beyond an immediate interpretation of what they see.
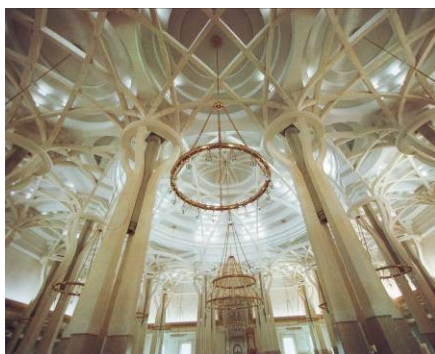
32.-In the *Rome Mosque* by Portoghesi there are no knots because the laces intersect; then there are no above-below relations between them and the composition is not so complex.

33.-When we make the laces to go repeatedly over and below the others we are introducing a different kind of order that when summed with the elusive character of the laces it results in a complex composition. *The Aljafería Palace* in Zaragoza.
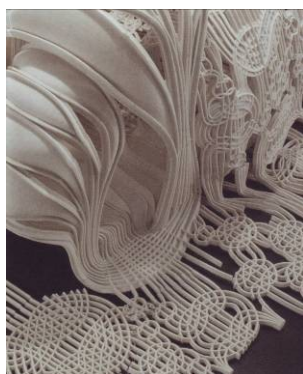
34.-In Miharu Morimoto´s *Carpet House* as in Celtic knots the curves of the laces allow us to follow the lines easier than if they were broken lines; that is why the last ones are preferred in Islamic interlace patterns.

35.-By colouring the laces we can see and understand better the different pieces of a pattern. Mosaics in the *Hall of the two Sisters of the Alhambra*.

A pattern that makes us impossible to see and connect its figures is making us to join little pieces of information for creating a mental whole. Interlace patterns are the clearest examples of how a configuration can go counter current to our way of perceiving shapes; they disconnect what we see as connected and connect what we see as disconnected; they are designed to escape from sight.

36.-We always group or connect visually collinear separated lines, but in interlaced patterns this collinear lines should not be connected together because they belong to different laces. In this case what we connect visually does not help us but hinders our understanding of the knotted pattern. Furthermore, in these patterns the coloured figures we see are not surrounded of one single lace contour, because the figures are just the space left by several independent laces; then the figures do not help us in finding any complete lace because they are not correlated. The *Mausoleum* of *Mohammed V*, Rabat.

37.-The figures in the background may be painted in a way that do not allow us to create an infinite plane behind the interlace pattern (something that would help us in perceiving it). Furthermore there are patterns where the colours in the background create new linear figures or paths. In these Mosaics from the *Mechouar of the Alhambra* we can find a black and an orange "secondary" lace.

Interlaced patterns have two different kinds of ordered configurations that are in contact, one of the laces and the other of the figures in the background. In spite of the fact that we cannot pay attention to both simultaneously, they are two ordering systems waiting for being understood as a whole.

7. Compound and indescribable shapes

Some shapes like spheres are regular and convex in their entire surface. That is why we see them as one single unit, a three-dimensional figure in space. A different situation occurs when we find differences in the direction of an object surface. The concave folds are the principal characteristic we use to divide objects in parts; they consist in superficial creases pointing to the inside of the object [15]. Besides concave folds superficial differences in other qualities of a shape like colour, pattern or texture, also divide the objects in parts or segments.

Dividing clearly an object in simpler parts helps us to easily shape a mental idea of the total configuration, because we understand the object as an addition of pieces with different interpretations or mental descriptions.

38.-We can see the object as composed of different parts if we find on it concave folds, or differences in other more superficial characteristics like colour. In this model by Hermann Finsterlin both ways of separation reinforce each other resulting in easily visible parts. Colour helps us in seeing the continuity of the volumes intersecting each other.

39.-When there is a blurred separation between different parts, the comprehension of the whole may be hindered. In this case different shapes produced by extrusions, additions, and subtractions get fused in one single unit. We need to make a mental effort to separate and understand what we do not see clearly divided. Project for the *Nuragic and Contemporary Art Museum*, Cagliari, by Zaha Hadid.
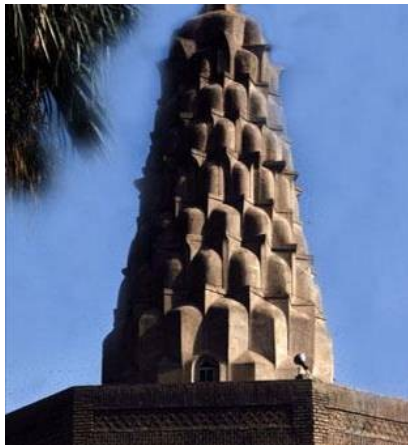
40.-Objects created by the addition of convex shapes do not require much visualization for understanding their configuration. We see the elements as if they were completed inside the object even when that continuity does not exist. *Zumurrud Khatun Tomb*, Baghdad.

41.-In considering a composition as the result of a subtractive process it is necessary to have an incomplete but still clear original shape from which some parts have been subtracted. *Vatican Palace*.
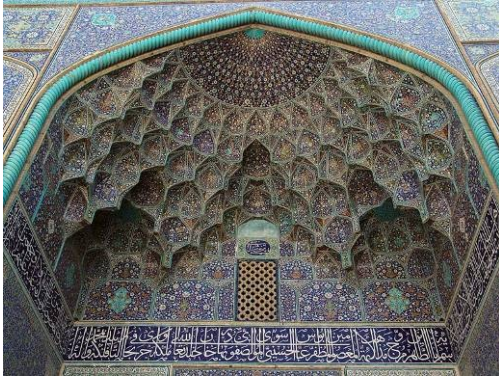
42.-Muqarnas cannot be easily understood as an addition of elements because of its concavities, but neither as created by a large quantity of subtractions because the original shape from which those subtractions have been made is no longer findable. Then muqarnas are experimented as complex shapes that need too much spatial visualization because we need to connect mentally the different tiers for understanding the whole. *Sheikh Lotf Allah Mosque*, Isfahan.

43.-When the building does not present cues telling us that it is the result of a revolution, extrusion, subtraction, intersection or folding, we are in front of an indescribable object. This kind of random configuration evade simplifications and do not give us shortcuts for their comprehension; then we have to make our mental image of them piece by piece. *Steel House* by Robert Bruno.

8. Understanding the order behind gradations

Redundancy is a good way of preventing us of paying attention to all the parts in a building; we can use the etcetera principle to extrapolate iterated parts or qualities beyond the ones we are looking at. Nevertheless some organizations are not exactly repetitive but posses characteristics that change gradually. The order behind those gradations is the principle by which we can explain what makes each element or segment slightly different from the one before or after in a sequence.

44.-By reinforcing the changing characteristics of a shape we push people to describe things in base of these varying qualities: in this case as a sequence of sections or layers transforming gradually. This kind of interpretation is helped by our stroboscopic way of "reading" series of varying but similar figures; like if they were in a temporal sequence. *Driftwood pavilion* by the AA.
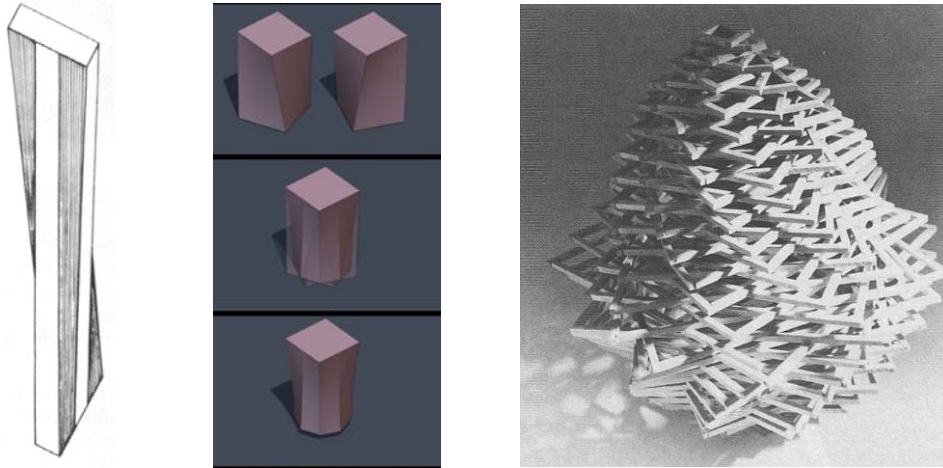
45.-The varying character of things is not taken into account in the most of the cases. This column made with transitional surfaces and rectangles is rarely times described in terms of its varying section. *Savona Railway Station* by Antonio Nervi and Pier Luigi Nervi.

46,47.-It is sometimes difficult to understand and visualize intersections of volumes, but understanding intersections of twisted shapes with contrary rotating sections can go beyond what we are able to visualize. When we experience a column designed by Gaudí we may not surpass a naïve description of it as a quadrangular prism with a gradual apparition of folds in its sides. We can call *implicit* to the not so evident kind of complexity of this column. Its process of creation could be made explicit by superposing slightly rotated sections in a similar manner to the stick model.

9. Conclusions

We can show the order in apparently simple or random configurations, but also hide the underlying order and create more complex structures. Meanwhile simple structures are easily reducible because we understand the order that creates them; the making of a mental idea of complex patterns is a difficult task.

Complexity treated as an experience does not depend just on the geometrical qualities of the pattern itself, but also on our way of perception and conception; the interpretations and hypotheses we make about what we see.

This paper has evaded a theoretical approach based on the explanation of concepts about what complexity is and has focused on the analysis of case studies. The search of complexity by artisans and architects was intuitive but nevertheless we can find in their designs many principles based in perceptual facts that accompany the geometrical ones. The search for complexity is the search for shapes that invite us to think.

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