Reflections on the Harmony of the Built Environment around Us

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***Abstract*—In this paper, the author tries to summaries his attempt to approach the concept, as a scientist, of artistic beauty and harmony. The notion is that beauty is objective within certain limits. Without accepting this notion, we can't talk about art. In this paper and more of them, I will deal with the scaling concept, the role of the symmetry and its relations with coloured pattern.**

I. Introduction

The virgin natural environment is regarded as pleasant because it is dominated by harmony. The environment built around us can also be harmonious, therefore, pleasing. The laws of natural harmony can also be applied on the environment built around us. With this notion we can discuss the harmony of the environment around us with a good scientific approach. In our investigations we will deal with its scale-like nature, its scale independence, and its symmetry as a concept associated with harmony. It should be noted, however, that this move is unidirectional and only existing structures can be considered and it can't be used as an aide assisting in the design stage or in the planning stage of replacing constituent elements.

To start we have to answer the following questions: What is it what we call harmony? Is it analogues with beauty? It is not easy to define environmental harmony; we can only describe its psychological affect. We find our surroundings harmonious where we feel happy. We find analogy for that feeling what we consider art. We regard paintings beautiful and harmonic, which are pleasing to look at and their view is pleasurable (Fig. 1).

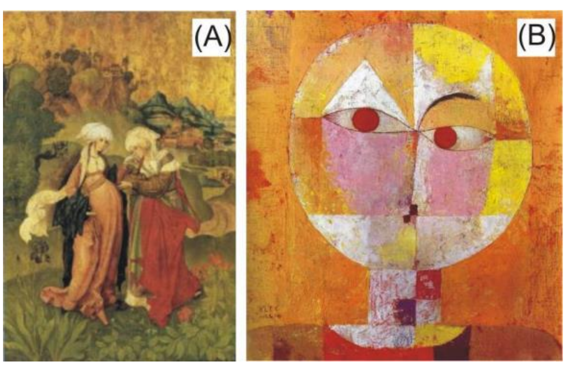

Figure 1. (A) Mester MS: Vizitation (1506); Paul Klee: Senecio (1922)

The same applies to musical compositions as well. The concept of beauty and harmony is not only the sole franchise of the art world. In mathematics, as a human activity, we can find "beautiful" connections. One of the widely regarded as most beautiful mathematical relation is from Euler: $e^{i\pi} = 1$ (here "e" is the base of natural logarithm "i" is the imaginary unit "π" is representing the ratio between the circumference of a circle and its diameter). The beauty of this expression lies in its simplicity and its capacity of unifying a number of different fields [1].

II. Scaling laws

Nature includes all kind of phenomena and patterns, dependent and independent of dimension [2]. In the first category, the fundamental attributes are determined by the characteristic length of the subject [3-5]. Examples occurring in nature are the evidence for them. A cricket, relative to its size, can jump higher than a lynx. An ant, relative to its size, can suffer a much bigger fall, then an elephant without any damage. In physics we can find more extreme examples. Take as an example the gravitational against the van der Waals force. Gravitation is a weak force but keeps the giant planets on their orbits. The van der Waals effect is the weakest force but keeps the water drop on the on the bottom of the lid of the pot. Defying the gravitational force, which keeps the planets on course, the water drop stays on the lid, because in the region of small dimensions it's not the gravitational force that is the dominant affect. An even better illustration of its strength can be found in the ramming of the wall of adobe houses, exhibited by the submicron clay mineral particles. Cutting a window on an adobe house wall, which was not exposed to moisture, is not an easy task because the wall's hardness is equivalent to that of concrete.

Figure 2. (A) Contry house in Őrség (small house); (B) Castle Nádasdy in Nádasladány (large house)

There are patterns in the environment built around us which will not automatically increase its size with the size of the object. It is obvious, that in a dwelling the size of openings (i.e. doors) only change within certain limits. The dimensions of doors in a large mansion or in a small bungalow hardly differ (Figure 2). These dimensions are determined by its functionality and human body size. The size of the steps of a staircase falls into the same category. No living accommodation can be increased by a fixed ratio. Leaving this out of consideration and the designer will end up with an edifice out of proportion. Laws like these are fundamentally gut feelings of the designers. These feelings are rarely broken unless the designer is led by the desire of creating something extraordinary provocative, ignoring the environmental functionality of the object. Similar extravagant steps cannot be mistaken for beauty or harmony. We will not list cases to the contrary.

III. Scale independence

In nature there are a large number of patterns with scale variation [2-5]. These kinds of objects are for instance clouds, shores of continents, etc. Trees and their branches are typical scale independent objects. A small tree nearby and a big tree from a distance looks very much the same. Leafs, of a big walnut tree, do not differ from that of a small walnut tree. The difference is only in the quantity of leafs on the tree, which is much more numerous on the big tree.

The scale independence in edifices manifests itself mostly in the ratios. The relations between the distances between antique columns and the heights between floors were subject of investigations for a long time. These ratios often coincide with known laws of statics. For instance Alberti and Blondel's conformity rules, which were known earlier, can be observed in the Renaissance, in the middle Ages as well as in the antiquities. The ratios are demonstrable with the angles or the bordering diameters. As examples we mention one antique (temple of Poseidon), one Gothic (Dome in Milan), one Renaissance (Palazzo Rucellai) and one edifice from the 20th century (Corbusier's Villa Stein).

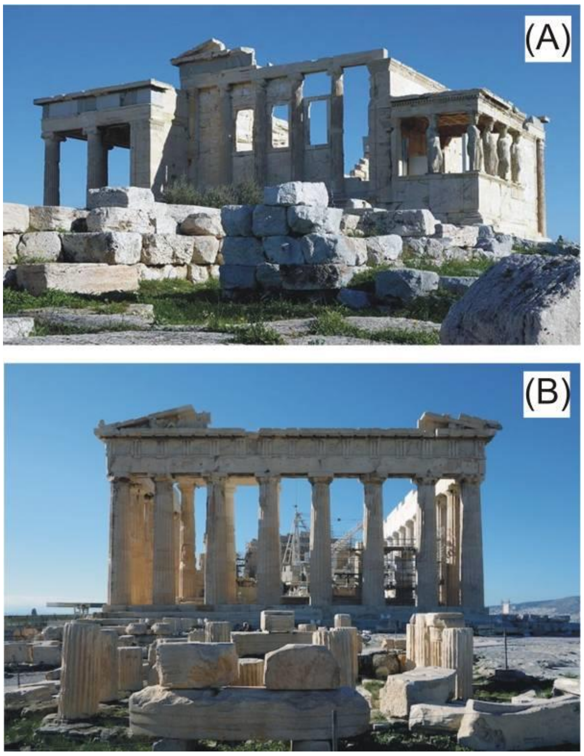

Figure 3. (A) The Erechtheion, Athens; (B) The Parthenon, Athens

Scale independence can be observed not only in architecture but in its close relation, called urban planing. The trees forking, gradually thinning branches or indeed roots, always try to fill uniformly the available space, starting from the same tree trunk. We can find the same pattern in living creatures as blood vessels as well as in the delta of the branching, alluvium carrying river. These formations are created by the practicalities and shaped to their actual form. The road system of a natural settlement is greatly influenced by the surface morphology of the area (relief of the ground, location of rivers or lakes, etc.). In the road network of an undisturbed settlements, which developed naturally we can often discover similarity to this ramifying net.

IV. Symmetry

One of my old professors Charles Simonyi put the following question to the undergraduate audience: "What is common between Maxwell's equations and a Gothic

Cathedral?" Not waiting for the stunned undergraduates to recover from their shock he came up with the following answer: "It is the mutual beauty". The first eye caching attribute is the symmetry [6]. Both the electric and the magnetic field have symmetrical properties. A change in the electric field creates magnetic field and vice versa. Similarly a Gothic Cathedral creates the impression of being symmetrical (Figure 4). In closer scrutiny however we discover that the symmetry is not perfect in every detail. For instance in science, one of the deviations is the existence of the electric monopole against the missing magnetic monopole. Similar deviations can be observed in the Gothic Cathedral. For instance the rosettes show shift symmetry and not mirror symmetry.

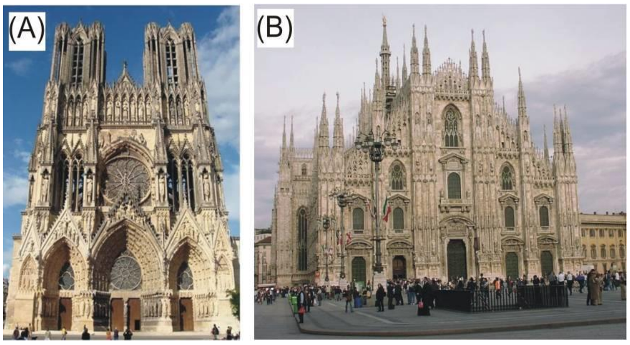

Figure 4. (A) Ghotic cathedral, Reims; (B) Duomo di Milano

Nature is full of symmetry. The flowers are always symmetrically arranged on the plants, it is mostly rotational symmetry but there are flowers with mirror and shift symmetry as well. In the animal kingdom the axial symmetry is dominant. Insects as well as mammals are normally symmetrical on the axis of their direction of movement, although there are always exceptions to this rule. The human body and face also have axial symmetry. In physics symmetry is very frequent. The most prominent examples are the crystal formations, but it can be found in elementary particles like the electron positron pair. As we said the electromagnetic field shows the same symmetry. This however is only true in a larger scale. We showed in the example the violation to this rule in a electromagnetic field. The matter - antimatter pair is not symmetrical, since the difference between their quantities in the universe is substantial. The biological symmetries show a similar pattern, therefore they are not perfect symmetries. An example is our internal organs. Symmetry has its own relations with beauty and harmony. A beautiful face of a female delights us and its features give us the impression of perfectness. Let us make a frontal picture of this beautiful face. Cut the picture on the center line and with the use of the right and left part create two pictures with perfect axial symmetry. The resulted two pictures, created this way from the left and right sides will not be appealing as much as the original picture, therefore the perfect symmetry as a necessary attribute belongs to neither to beauty nor to harmony. Often denies them.

Figure 5. Coloured block houses (A) in the XIX district and (B) XVIII disctrict of Budapest

In architecture we find the axial, shift and rotational symmetries together. We can also find the tendency for the braking of this symmetry. First of all we find the braking of the axial symmetry. Look at an object in architecture in large scale and the smaller parts rarely look symmetrical. These are usually more pleasing to the eye than the perfect symmetry. During socialism in the building estates the blocks of flats were of the same size same shape and same colour, located in the same distance from each other, located in shift symmetry. Residents often complained that they lost their way or accidentally entered the wrong flat due to the uniformity of the interior design. Nowadays this is rectified by distinct colouring and by planting trees and bushes between blocks (Figure 5). Further to that the various buildings are constructed from building parts of differing shape [7, 8]. The results in a more pleasing and more practical arrangement, geared to the use and purpose of the dwellings. The rotational and other symmetries, also their violations, can be found in historically famous edifices (Rotundas, cathedral apsis and side-altars) and also in industrial buildings. Bridges and other man-made constructions are generally also symmetrically engineered (axial or other symmetry). It can be demonstrated that symmetry is not a necessary condition for optimal solution imperdiet sagittis.

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