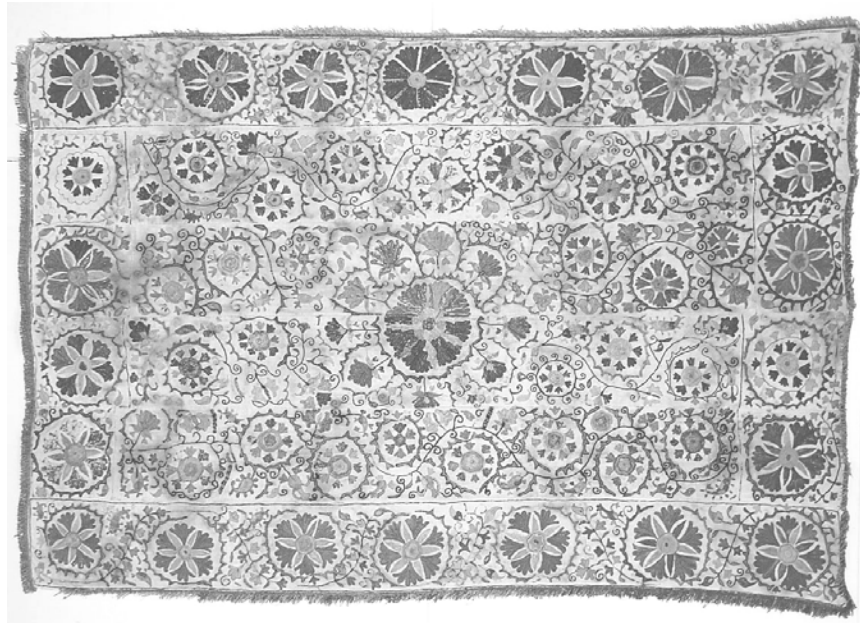


# Symmetry and Symmetry-Breaking An Approach to Understanding Beauty

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## Abstract

Considering the relationship of symmetry and beauty, the author examines three textiles from the collection of Doris Duke at Shangri La in Honolulu. Referring to abstract expressionism of the 20<sup>th</sup> century as antithetical to symmetry, and the Arts & Crafts Movement of the 19<sup>th</sup> century as countering the insistency of industrial mass production, Bier explores the relative roles of symmetry and symmetry-breaking in the construction of three embroideries (called *suzani*, after the Persian and Tajik word for “needlework”), using as her point of departure a recent research initiative, the Shangri La Suzani Project. The study of colors, motifs, stitches, designs and patterns suggests the identification of a local aesthetic preference for local symmetries without global symmetry, and global symmetries without local symmetry. These embroideries typify styles associated with Bukhara in the 19<sup>th</sup> century. The results of this research lead to more general consideration of symmetry and symmetry-breaking in the construction of beauty.



**Figure 1** *Suzani I* (embroidery), from the Collection of Doris Duke at Shangri La, Honolulu (85.29).

## 1. Introduction: The Approximation of Symmetry in Nature and Art

Symmetry, whether in art or in nature, is only ever approximate [2]. The human body, a tree, the gait of an animal, seasonal cycles, all offer examples from nature of approximate symmetries that appear to be regular in their periodicity, but which, in fact, are slightly irregular in the repetition of forms through time and space. This natural irregularity in seashells may be seen in the patterns generated along the leading edge, described as algorithmic beauty [18]. This term, combining concepts of mathematics and

aesthetics, is also apt for the description of the arts of traditional cultures, which although algorithmic in their construction, are often perceived as being imperfect with respect to the resulting symmetries. Whether in the cutting and piecing of strips of wood or bone for inlays, or the stamping of leather or the printing of cloth, or the juxtaposition of individual segments of color in a carpet [3], or the journeys of the needle to embroider a fabric, the mechanisms used to create designs and manipulate them to form patterns often relies upon algorithms of process as developed within individual craft traditions. Symmetry, whether wittingly or not, is most often the organizing principle that structures the patterns [11].

The arts of traditional cultures, generally, express a playfulness that is dependent on symmetrical constructions for designs as well as for patterns [24; 25]. But abstract expressionism in the 20th century sought to avoid symmetry all together. In contrast, the works of M. C. Escher [19] countered this trend, playing extensively with symmetries and tilings, drawing much of his inspiration from Islamic designs he sketched while visiting the Alhambra in Spain. Narrative representation and pictorial depictions, as developed since the Renaissance in Western arts tend to be asymmetrical, while relying nonetheless upon the assumed external symmetry of the human body. One respected art theorist, the late Meyer Shapiro, takes a highly skeptical approach to the notions of “perfection, coherence, and unity of form and content” in the arts [1:3-13]. And recent assessments of abstraction argue for a relationship between abstraction and ornament that is highly structured and dependent upon underlying mathematical principles [7].

In studying the arts of Islamic cultures, I have often pondered the nature of beauty, sometimes in relation to the beauty of nature. What has struck me on more than one occasion is that beauty seems to lie in symmetry-breaking, rather than in symmetry. The truest approximation of symmetry came only with the Industrial Revolution, quickly countered by the Arts & Crafts Movement and the philosophical writings of John Ruskin and the designs and writing of William Morris, who advocated and promoted the values of hand-made objects and craft traditions, with their natural and organic standards of beauty. One contemporary fiber artist, Katherine Westphal, specifically sought in her art to overcome what she called “the tyranny of the repeat” that so characterized industrial mass production [20].

## **2. *Suzani* from the Region of Bukhara: The Artistic Appropriation of Symmetry**

In the case of embroideries from the region of Bukhara (**fig. 1**), called *suzani* (“needlework” in Persian and Tajik languages), a particular style emerged in the 19th century in which there is a preponderance of intentional symmetry-breaking. At first glance, these embroideries appear to be symmetrical. But what appears to be symmetry, is really only the implication of symmetry. More careful observation reveals the visual dominance of asymmetry within a symmetrical layout. The implication of symmetry seems to seduce us into thinking there is symmetry where there is none. This paradox may be more clearly expressed in terms of global symmetries and local symmetries. Global symmetries are present in the overall layout of the composition in which there is a rectangular central field surrounded by a main border defined by narrow inner and outer borders. The horizontal and vertical axes of reflection that structure the global symmetry, however, do not structure the layout of individual motifs and design elements. It does not break down to evince symmetry at the local level. Paradoxically, there are numerous local symmetries, which may be seen among individual motifs and design elements, but these do not repeat to form global symmetries.

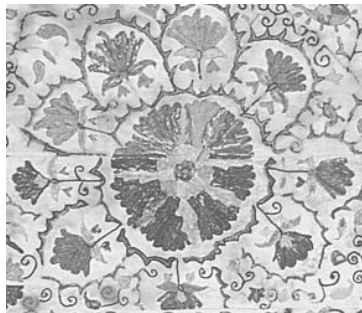
A richly diverse collection of these embroideries was acquired by Doris Duke in the middle of the 20<sup>th</sup> century, which she displayed at Shangri La, her home in Honolulu [17]. She used the *suzanis* in a manner much in the way they were intended, as hangings and covers. The strength and importance of this early collection has inspired a recent initiative, the Shangri La *Suzani* Research Project [5], undertaken to support the development of an exhibition scheduled for Fall 2005 at the East-West Center in Honolulu, to be organized by Sharon Littlefield and Michael Schuster.

### 3. Doris Duke's Collection of Suzani at Shangri La

Doris Duke married James Cromwell in 1935 and together they embarked on a year-long honeymoon that took them around the world. The last stop was Honolulu, where they stayed longer than anticipated; eventually they purchased a spot of land and proceeded to construct a house at Black Point, which would ultimately house many of the acquisitions of their honeymoon [17]. Among the purchases made in Bombay, India, was a selection of embroideries identified as “sujnee,” today known as suzani after the Persian and Tajik word for needlework [15]. Duke's purchases of these materials long preceded the acquisition of suzani by European and American collectors and museums, which did not occur for the most part until the late 20<sup>th</sup> century. George Hewitt Myers, founder of The Textile Museum, purchased his first suzani as early as 1916, but increased demand for suzani among collectors in Europe and America did not grow strong until the promotion by rug dealers in the early 1980s [6]. Duke continued to acquire suzani over the years; at the time of her death in 1993, she had fifteen examples with numerous additional textiles and other objects related by style, techniques, and design. Examination of three examples here will suffice to demonstrate the attention given to symmetry and symmetry-breaking by the embroiderers and seamstresses who worked on these objects. To judge by the range of published work concerning these embroideries, which draws from ethnographic research, museum records, collection catalogues, and exhibitions [15; 21; 22; 27], these textiles were embroidered by groups of women who were engaged in preparing dowry items for a bride's marriage ceremony and wedding celebration.

#### 3.1 *Suzani* I (85.29): Variations upon a Theme

The first suzani to be illustrated (**fig. 1**) is composed of six strips of cloth basted together to create a ground fabric. Each strip is 10.5 inches wide. The designs would have been drawn on the six strips, which were separated and then joined again after having been embroidered. As a result, typically, there is a slight disjuncture in the embroidered patterns at the seam joins. All of the embroidery is executed in chain stitch. Thirteen colors have been identified (dark red, purple, reddish brown, orange, yellow, light green, light blue, light violet, light pink, medium green, dark blue, yellow green, and black). The four colors described as light are variegated. In spite of some fading on the front face of the object, initial visual inspection suggests an even wider range of colors, not only because of the variegated yarns, but also because of the many combinations of colors juxtaposed with one another. The colors on the back face retain more vibrancy; the applied looped fringe shows fading and considerable damage and loss.



**Figure 1a.** Large central rosette in field of *Suzani* I (**fig. 1**, detail).

With a central field surrounded by a main border, the layout of the composition is also typical of suzani produced in and around Bukhara. At the center a large floral rosette (**fig. 1a**), divided unequally into eight scalloped sections, has nine radial extensions each of which supports a composite blossom in profile, offering a hint of the variations in local symmetries. Each blossom is different, offering further evidence for the magnitude of these variations in radial symmetries with the use of reflection.

Throughout the field smaller rosettes are set within undulating vines that comprise rows, each row corresponding to a strip of cloth (**fig. 1b**).



**Figure 1b.** Uppermost strip of central field of *Suzani I* (**fig. 1**, detail).

A single row of larger rosettes constitutes the main border (**fig. 1c**), which surrounds the central field on all four sides. Most but not all of the rosettes in the border are segmented into sixths with a radial arrangement of petals. Although similar, none of these rosettes are identical, and their orientations are all slightly different. In the top border, shown below, the central rosette is divided into eighths with a scalloped arrangement roughly parallel to that of the central rosette in the field, which is larger.



**Figure 1c.** Upper horizontal border of *Suzani I* (**fig. 1**, detail).

Although the rosettes of the border (**fig. 1c**) and the rosettes of the central field (**fig. 1b**) are each set within a scalloped outline, the rosettes in the border are somewhat more dominant. There are several factors that contribute to this perception. The border rosettes are larger, and they have higher proportions of dark or vibrant colors, and they are surrounded by undulating vines with more leaves. In contrast, the rosettes of the central field (**fig. 1a**) are relatively smaller, are divided variously into six or seven or eight segments, and are surrounded by vines with fewer leaves and scrolls with curling tendrils.

There seems to be a harmonious play between the abstraction of the approximately symmetrical rosettes, removed from any identifiable floral form, and the somewhat more naturalistic leafy vines and scrolls with curling tendrils. What characterizes this *suzani* is a dynamic balance between uniformity and lack of uniformity, a tension between sameness and difference. It is the combination of symmetry and symmetry-breaking that seems to keep the eye wandering and the mind engaged.

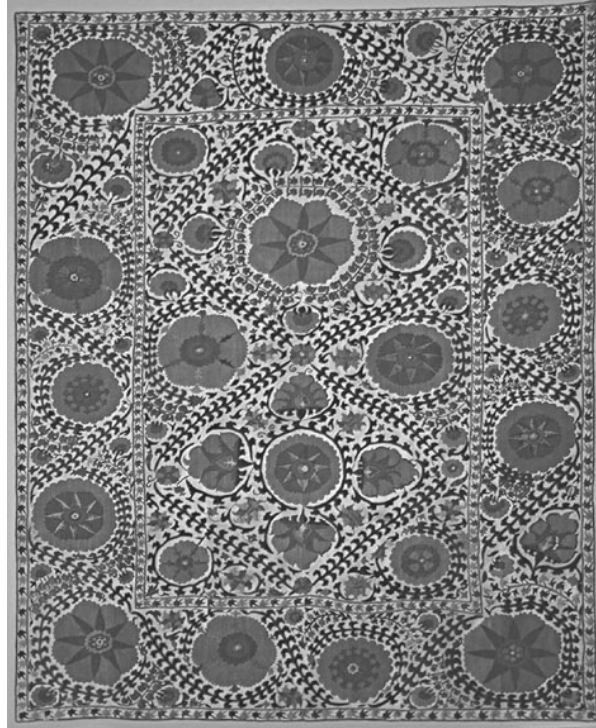
### **3.2 *Suzani II* (85.39): Global Symmetries and Local Symmetries**

#### **3.2.1 Global Symmetries, No Local Symmetry**

The layout of the composition in the second example of a *suzani* (**fig. 2**) is carefully articulated by the prominent use of leafy vines composed of green leaves and stems all outlined in black. The layout implies a strong central vertical axis and two secondary side axes which define the surrounding side borders. In addition, there is a main horizontal axis dividing the central field, approximately at the middle and extending into the main borders right and left, and two secondary axes which, again, define the surrounding border at top and bottom. In addition, in the central field there are two secondary horizontal axes, which divide the upper and lower sections in half, with reflectional symmetry above and below each horizontal axis and to the right and left of each vertical axis. In the border, two subsidiary axes divide each of the main border segments horizontally (top and bottom) or vertically (sides). This division roughly corresponds to the layout of most Oriental carpets, made in a broad geographic region stretching from Turkey across Central Asia to Western China, a significant visual relationship described and assessed in the recent documentation of a private collection of *suzanis* in New York [16].

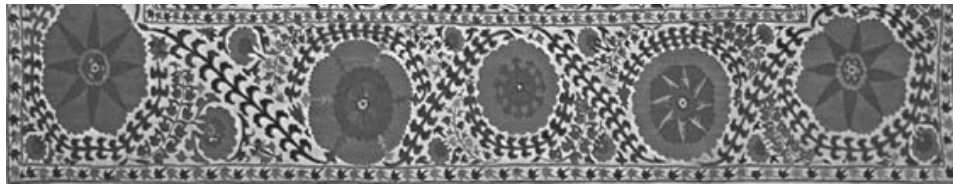
### 3.2.2 Local Symmetries, No Global Symmetry

Analysis of the borders of this suzani as line symmetries reveals the use of glide reflection as described by the zig-zag vine with opposite leaves (**fig. 2a**). Working in visual opposition to this vine is a second vine, also with opposite leaves. The course of this second vine, however, is curvilinear, but it is regularly interrupted. At the local level, these symmetries of form are at best approximate.



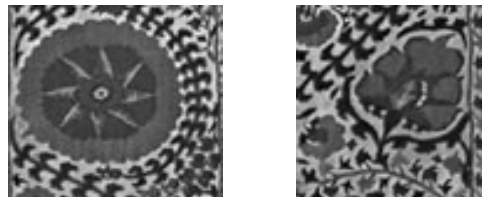
**Figure 2** *Suzani II*, from the collection of Doris Duke at Shangri La, Honolulu (85.39).

Defining the main border, the narrow inner and outer borders (**fig. 2a**) show glide reflection in a linear pattern of two leaves with color alternation.



**Figure 2a.** Left vertical border of *Suzani II* (**fig. 2**, detail), viewed sideways.

When one examines the individual motifs of floral rosettes and blossoms in profile (**figs. 2b-c**), leafy vines, and other design elements of this suzani, there is local symmetry only. For any given form, locally symmetrical by rotation (**fig. 2b**) or reflection (**fig. 2c**), it is not repeated even approximately in a symmetrical location within the composition of what appears to be a symmetrical composition.

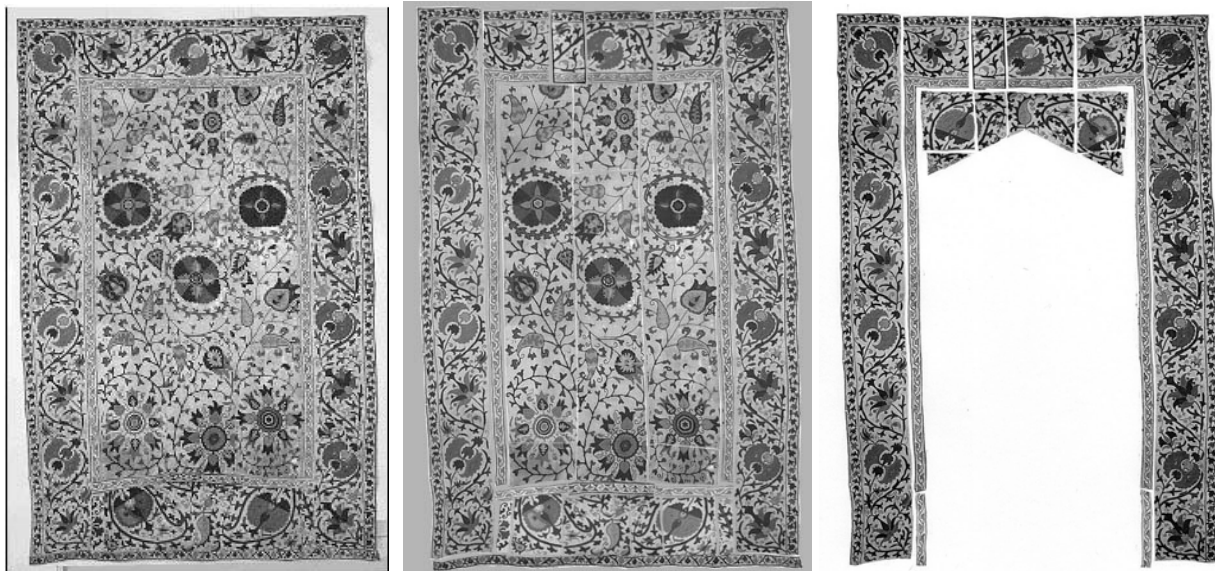


**Figures 2b-c.** Rosette (left) and blossom in profile (right) from main border of *Suzani II* (**fig. 2**, detail).

The global symmetry evident in the layout may be identified as a symmetry of space, but not of form. The local symmetries evident in the floral rosettes exhibit symmetries of form, and symmetries of color, but these are not replicated within the global symmetry of space.

### 3.3 *Suzani* III (85.30): Two Suzanis in One

The third *suzani* to be studied here (**fig. 3a**) presents a different set of issues. The textile is actually composed of twenty-six pieces, pieced together as an assemblage (**fig. 3b**). On inspection, the central field may be recognized as having a different ground fabric than that of the main border (**fig. 3d**). The main border seems to be integral with the inner and outer borders. Closer inspection of the entire object in its present condition reveals many seams, which are hand-stitched or machine-sewn. Detailed examination of seams, selvages, and cut edges folded back, leads to the recognition that this *suzani* is composed of parts of two *suzanis*, plus a couple of in-fill pieces. The border of this textile exhibits a series of diagonal seams that led us to recognize the lines and angles of a niched *suzani* (**fig. 3c**), the spandrels of which were flipped and repositioned to form the horizontal border at the top. The fragments that comprise the central field show selvages in a horizontal orientation, whereas the norm for a *suzani*'s construction shows a sequence of narrow loom-widths, with a selvage on each side, oriented in warp direction.



**Figure 3a** (left) *Suzani* III, from the collection of Doris Duke at Shangri La, Honolulu (85.30).

**Figure 3b** (center) *Suzani* III is assembled from twenty-six fragments, sewn together (85.30).

**Figure 3c** (right) Reconstruction of niched *suzani* from main borders of *Suzani* III (**fig. 3a**).

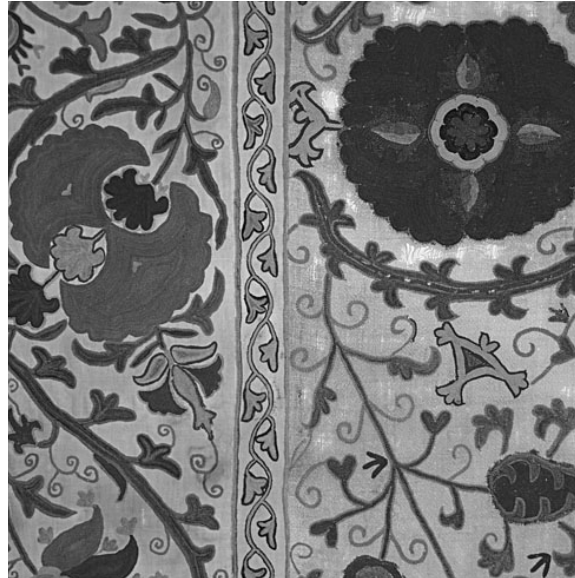
#### 3.3.1 A Niched *Suzani* with Symmetry and Asymmetry

The niched *suzani* (**fig. 3c**) shows an asymmetrical element – a tear-drop shaped leaf – at the top of the niche, flanked by floral designs. Disposed symmetrically on either side of the central element, an almost circular blossom is shown in profile and set within a larger tear-drop shaped form defined by leafy vines. The symmetrical disposition betrays the asymmetry of the tear-drop shape, the design of this *suzani* displaying both symmetry and asymmetry in the playful use of this form. The main border shows flower blossoms in alternate alignment within an undulating vine composed with glide reflection. The inner border is composed of a vine with an arrangement of small tripartite leaves with glide reflection (**fig. 3d**).

#### 3.3.2 An Older *Suzani* with Balance and Harmony

The central field of *Suzani* III (**fig. 3a**) in its present configuration shows no symmetry of space or form. The large rosettes each exhibit a radial symmetry with four-fold reflection or rotation; smaller rosettes

with radial extensions show reflection in the treatment of each tulip-like flower. They are displayed without respect to symmetrical placement in the field. Blossoms on stems, however, are displayed symmetrically in opposition to one another. Many styles of vine are variously composed with opposite or alternate leaves. The overall effect, in spite of a lack of symmetry of space or form, is one of harmony and balance. Color, scale of motif, and reserved ground each contribute to this pleasing visual array.



**Figure 3d** Detail of border (left), inner border (center), and central field (right) of *Suzani III* (**fig. 3a**, detail).

#### **4. Suzanis and Symmetry-Breaking**

The women who embroidered the suzanis in the Bukhara region were very skillful in their use of symmetry and symmetry-breaking to achieve visually stunning effects. Even if they were mathematically illiterate (or innumerate), they understood the principles of symmetry and symmetry-breaking either intuitively or experientially. Designers, or those who drafted the designs, would also have contributed to the determination of placement of individual motifs. What they achieved together aesthetically plays with our perception. The eye seems to be able to accommodate the irregularities of symmetry-breaking both at the global level and at the local level, such that at first glance suzanis generally appear to be symmetrical. That closer visual study reveals local symmetries and global asymmetry, and global symmetry and local asymmetry, is surely a testament to the accomplishment of the embroiderers. Whether they operated intuitively or experientially may never be known. To judge from the best examples that survive in museums and private collections today, the embroiderers clearly exerted careful efforts on several distinct levels. On one level, they worked at the execution of individual stitches; at a second level, they determined to juxtapose stitches in parallel rows or concentric rings; thirdly, they determined the composition of individual motifs and connecting elements; fourth, they followed the design and overall layout as drawn on the strips of the ground fabric. The use of contouring and outlines attests to an awareness of playing with the illusion of a third dimension, and the juxtaposition and arrangement of stitches gives clear evidence of the intention to catch light in intriguing ways. Visual impact also depends upon the quality of silk embroidery yarns, and whether the yarns are spun and plied. These factors also strongly affect the reflection of light, and hence, our perception of color.

Together, the use of materials and these working habits constitute a praxis that plays with symmetry and symmetry-breaking to create a perceptual paradox. Symmetry-breaking requires the anticipation of symmetry; the breaking of that expectation in art can be achieved through changes of color, shape, scale, or placement, and the changes can be binary, algorithmic or random [4]. Suzanis made in the region of Bukhara in the 19<sup>th</sup> century are characterized by many such changes to effect symmetry-breaking. Indeed, rarely does one find a beautiful suzani without these distinct characteristics.

## 5. Symmetry and Beauty: Some Comments

The relationship of symmetry and beauty has a long history in human thought, and it is often cited with reference to the canon of harmonic proportions advanced by the Greek sculptor and theoretician Polykleitos [26:3]. In the second half of the 20<sup>th</sup> century, this relationship attracted the attention of mathematicians and physicists in the wake of relativity [26;14;16], and among historians of art with a particular interest in theory pertaining to order, harmony and ornament [8;9;23]. The evidence from nature, however, leads us to suggest a different interpretation, which is captured in the aesthetic present in the three examples of embroidery from 19<sup>th</sup> century Bukhara studied in this paper. It is not symmetry itself that renders something beautiful, but rather symmetry-breaking combined with symmetry. Symmetry-breaking can only exist with an expectation or implication of symmetry. This would seem to be true, too, for musical compositions, as well as for the strength of viruses in their ability to resist treatment. That this aspect of natural beauty is captured in the *suzanis* of Bukhara from the 19<sup>th</sup> century, and in the then contemporary aesthetic expressions of silk and cotton resist-dyed panels of *ikat* [12;13] is evident in all examples of 19<sup>th</sup> century *suzanis*, not just the three cited here. The recognition of this aesthetic raises several provocative questions that warrant further consideration with reference to the role of symmetry-breaking in the arts more generally and in comparison to the role of symmetry-breaking in nature. The questions pertain not only to the qualities of symmetry-breaking, but also to the relative proportions of symmetry to symmetry-breaking: How much is too much? How much is not enough?

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