The Fifteen Geometric Properties of Wholeness
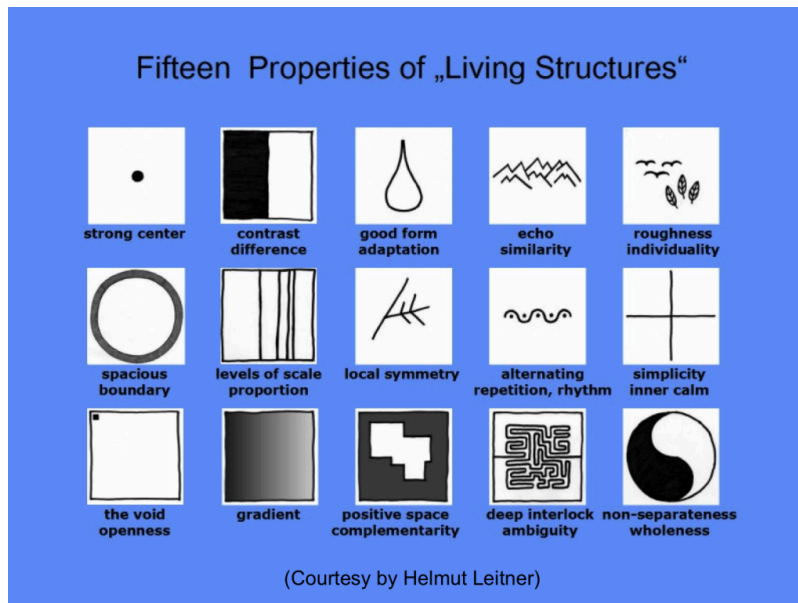
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From the book *The Battle for the Life and Beauty of the Earth: A Struggle Between Two World-Systems* (Center for Environmental Structure) by Christopher Alexander.

Fifteen Properties of „Living Structures"

strong center	contrast difference	good form adaptation	echo similarity	roughness individuality
spacious boundary	levels of scale proportion	local symmetry	alternating repetition, rhythm	simplicity inner calm
the void openness	gradient	positive space complementarity	deep interlock ambiguity	non-separateness wholeness

(Courtesy by Helmut Leitner)

The Fifteen Geometric Properties of Wholeness

Here are the fifteen properties, now expressed as fifteen transformations that generate life. These provide the active juice with which a living system provides the range of possibilities with which we may work. Every living system uses these transformations. They are the active elements which go to work.

1) The **STRONG-CENTER** transformation. This is a generic transformation which simply makes the coherence of a center stronger, by making it more "center-like." It does so by calling on any combination of the other transformations. For example, if a center is embellished by a **THICK BOUNDARY**, additional centers are created, and the original center will (in most cases) become stronger. If a center is embellished by a **LEVELS-OF SCALE** transformation which creates new centers inside the original center, the center will, once again, become stronger – provided the placement of the smaller centers was chosen to have this effect. If the smaller centers create one or more **GRADIENTS**, supporting the orientation of the original center, and thus strengthening it, the same thing happens, but in a different way. Each of these transformations spawns (or generates) new centers, which fit in a natural way into the system of centers already in existence, and supports the wholeness which was there initially.
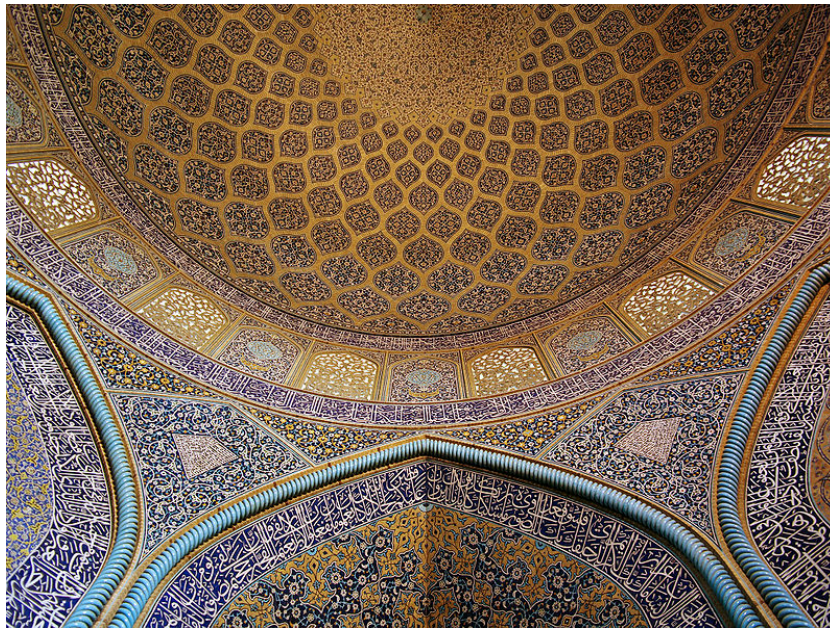
Credit: [Phillip Maiwald](#)

2) The **THICK-BOUNDARY** transformation. This transformation places a thick boundary around or partly around the zone occupied by a weak center, thus helping to make that center more coherent. The radial thickness of the boundary is large, sometimes of the same order or magnitude as the diameter of the original center being surrounded. It is large enough, anyway, so that smaller second-magnitude centers can populate this boundary, meaning that the thickness is at least one-quarter the diameter of the original center, and sometimes one-half of the original diameter, thus forming a thick band around the circle, where the band has the same thickness as the diameter that it now surrounds.

Credit: [Petrusbarbygere](#)

3) The **LEVELS-OF-SCALE** transformation. This transformation modifies the given center, by embellishing it with smaller centers. These smaller centers are typically one-half to one third the diameter of the original center, but sometimes smaller. They may be created within the original center, or in the space adjacent to it.

Credit: Jon Sullivan

4) The **ALTERNATING-REPETITION** transformation. This transformation repeats centers to form a local array. This may happen in one, or two, or three dimensions. The key effect of the transformation is that it typically then creates a second system of centers between the loose-packed array of the first centers, in such a way that the first centers and the second centers are made strongly distinct, by shape or material color, and become more coherent, by virtue of the alternation. In the course of the operation, the transformation often changes the shape of the first centers, to make the in-between, second centers well-shaped.

Credit: H. Zell

5) The **LOCAL-SYMMETRIES** transformation. This transformation strengthens a given center by introducing one or more local symmetries – most often bilateral symmetry. If the center already has a natural axis of orientation, the symmetry

is made to coincide with it. Otherwise, it orients the symmetry to make it as congruent as possible with the field induced by nearby centers (i.e. where it seems natural). It is best to apply the symmetry to a center that is already nearly symmetrical.

Credit: Derek Ramsey

6) The **POSITIVE-SPACE** transformation. This transformation is one of the most important and profound, but it is one of the hardest to define. It may be applied to any center, and helps to shape some of the so called "empty" spaces which fill out the interstices within the original center. The "positiveness" of space comes from a combination of good shape, local symmetries, boundedness and above all from the appropriateness of the space for purposes. This transformation is applied most typically to the latent centers formed in the space between other centers, thus giving these otherwise leftover spaces definite and recognizable form.

Credit: Alvesgaspar

7) The **ROUGHNESS** transformation. In the course of unfolding, as the wholeness-enhancing transformation push and shove to make various things happen, as required by the detail of the transformations, it happens, very often, that something does not quite fit neatly. Instead of creating a perfect or pristine shape, it is then necessary – absolutely necessary – to relax certain conditions, in order to make the configuration work successfully. For example, a putative rectangular building, when put on a difficult site, may need one corner to be slightly off – 90 degrees (perhaps 88 degrees or 95 degrees in one corner) – simply because of a tree that is in the way. In another instance, a doorway may need to be gently curved, and if left straight will fail to adapt itself to some recognizable and important geometric feature of the site.

In all these cases, the roughness that is introduced is created *of necessity*, because some aspect of the building's fitness for the site is more important than a perfectionist desire for Cartesian regularity. So this transformation gives the unfolding process permission to be rough and ready, when this serves larger and highly important aspects of an ongoing adaptation.

Credit: Sbork

8) The **GRADIENT** transformation. This transformation creates gradients that point toward or away from a given center. Some common gradients are gradients of size, gradients of contrast, gradients of spacing, gradients of orientation. The gradients are implemented through smaller centers that have the above mentioned characteristics, varying with position, magnitude, and orientation toward the parent center.

Credit: Brocken Inaglory

9) The **CONTRAST** transformation. The coherence of a protocenter is enhanced by contrast – whether of color, or material, or gradient, or density. The contrast transformation increases the contrast between the inside and the outside of the center, or provides some other differentiation which makes the center stand out more strongly from the field.

Credit: BS Turner Hof

10) The **DEEP-INTERLOCK AND AMBIGUITY** transformation. This transformation is used at an interface between two adjacent centers. Its purpose is to create a zone, usually an ambiguous zone, forming a third center between the two original centers. It is made ambiguous, in the sense that there are ties from one side, and ties from the other, with the result that there is a visible ambiguity about which of the two outer centers this new center belongs to.

Since the belonging of the third center, to the two centers adjacent to it, is ambiguous, this is often accomplished by mutually interlocking "peninsulas", which penetrate the ambiguous zone, first from one side, then from the other side, creating an interlocking configuration.

Credit: Øyvind Holmstad

11) The **ECHOES** transformation. This transformation has mainly to do with angles and curves and ratios. As the collection of centers grows, there will be certain predominant angles, or curves, or ratios or proportions, in the shapes that have been

created. The **ECHOES** transformation then uses the statistics of these angles, curves, and ratios that so far dominate the configuration as a whole, and introduces this statistic as a default in the drawing of subsequent centers that are nearby, thus slowly giving the whole system of centers a family resemblance shared by many of them.

Credit:

12) The **GOOD-SHAPE** transformation. This transformation directly influences shape. If some rough outline of a shape has been generated, this transformation examines the overall convex pieces of the shape, and tries, as far as possible, to strengthen or emphasize these pieces, within the segment of the curved boundary, in such a way that makes the overall shape more distinct, more recognizable.

Credit: Joe Schneid

13) The **INNER-CALM** transformation. This transformation is a clean-up tool working along the lines of Occam's razor. It simplifies a configuration. It removes, as far as possible, all superfluous structure. Any aspect of the configuration that is experienced as chaotic or complicated, instead of calm, is questioned as to whether it belongs there.

Credit: Stephane D'Alu

14) The **VOID** transformation. This is a pervasive transformation, working at many levels of scale. The basic idea of the transformation is that at the core of any center, there is always some undisturbed and perfectly peaceful area which lacks busyness or excessive structure. It is very important that each serious center, has, within its boundary, some area or volume

like this. Often this area is large in extent, compared with all the other elements that have a great deal of structure. This transformation can probably be expressed arithmetically, as a statistic on the whole configuration.

Credit: Tauri Pärna

15) The **NOT-SEPARATENESS** transformation. This transformation comes into play after the majority of centers have been established. The purpose is to overcome any separation that is caused between the configuration and its environment, or between any individual center and *its* immediate environment. To mobilize this transformation, wherever a boundary is too sharp, bridges should be formed, by chains of centers, which cross that boundary, thus creating a softer and more permeable edge. In successful applications of the transformation, the chains of centers which it generates sometimes have considerable length and are anchored in the space on either side of the original "hard" edge by gradients of size, color, contrast, or other variables that vary with distance from the edge.

This transformation acts as an instruction to soften the hardness of an edge that defines a center. It can sometimes be very complicated. This transformation does not have a particular outcome: it rather defines a range of possible actions, which may all have the effect described above.

The Overall Quality of a Creation System

These fifteen wholeness-extending transformations were used thousands of times, over and over again, to create the design of the Eishin Campus and build it. Chapter 11 (Flags: The Reality of the Land) and chapter 12 (Symmetry, Simplicity and Grace) describe some of the many decisions that were made the implement of the life-giving qualities and properties needed in creating any part of the structure of the campus. They are means to the creation system we can use on a grand scale, throughout the world.

The [Eishin Campus](#), Tokyo, Japan

In the next chapters, we shall see just what actually happens, when we apply the wholeness-extending transformations to a part of the world, and what happens after that. Although the present chapter has been written in an analytical tone (and is of necessity, therefore, rather dry), the next chapter (chapter 23) will show us how this procedure deals, above all, with feeling and intuition, and shows us a grand vista of process that is carried by the emotions and connects us, mentally and intellectually, with phenomena that are like dreams. The dreams go to work for us on the holistic level, and speak to us as artists – thus opening a vista which is exiting and inspiring. We finally experience what that means to connect with the wholeness of the world *directly*. - *Pages 431-438*