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Lecture 6

A. Alexander’s 15 fundamental properties

B. Three laws of architecture
Introduction — morphological features

• Already derived some structural rules
• *Universal scaling*
• *Wide boundaries*
• *Scaling coherence*
• *Universal distribution of sizes*
• How many such rules are there altogether? Completeness?
Background

• The preceding lectures all build up to the fifteen fundamental properties
• Some of the properties will as a result be understood now as mathematically conclusive, practical, and logical
• The others become easier to accept, and together they form a complete set
A. Fifteen fundamental properties

- Morphological features that resonate with the human senses
- Found in man-made form and structure
- Independent of culture, period, or region — something innate
- Also present in natural forms and objects
Presentation

• Christopher Alexander derived the 15 properties by observing structure that “is alive” in buildings, cities, artifacts

• Alexander’s “The Nature of Order, Book 1: THE PHENOMENON OF LIFE”

• Hierarchy: nature; biological forms; animals; human beings; cultures
List of properties

• 1. Levels of scale
• 2. Strong centers
• 3. Thick boundaries
• 4. Alternating repetition
• 5. Positive space
• 6. Good shape
• 7. Local symmetries
• 8. Deep interlock and ambiguity
List of properties (cont.)

- 9. Contrast
- 10. Gradients
- 11. Roughness
- 12. Echoes
- 13. The void
- 14. Simplicity and inner calm
- 15. Not-separateness
The second set of Leitner diagrams

• Diagrams drawn by Helmut Leitner, a software engineer in Graz, Austria
• Schematic sketches — illustrate the fifteen properties at a glance
• Presented at the 2007 conference entitled “Structure-Process-Patterns” in Vienna
• Leitner’s book “Mustertheorie (Pattern Theory)” does NOT contain his diagrams
Helmut Leitner’s book: “Pattern Theory” (in German)
1. Levels of scale
Scaling hierarchy

- Levels of scale — spaced closely enough for coherence, but not too close to blur the distinction between nearby scales
- I gave mathematical rules (in the first lecture) for generating the correct scales via the logarithmic constant $e$ and the Fibonacci sequence
Accessible scaling hierarchy is essential for adaptation

• The whole point of adaptive design is to satisfy needs on the human scales
• There is an entire range of human scales, from 2 m down to < 1 mm
• Build appropriate form — rule only says that you must accommodate all these scales; shape depends on centers!
2. Strong centers
Theory of centers (lecture 5)

- Each “center” ties a substantial region of space together coherently
- Each center combines surrounding centers and boundaries to focus
- Centers support each other on every scale — recursive hierarchical property
Two types of centers

• Two types of centers — “defined” and “implied” — interact coherently
• “Defined” center has something in the middle to focus attention
• “Implied” center has a boundary that focuses attention on its empty interior
• Visual focus enhances function
3. Thick boundaries
Thick boundary

• According to universal scaling, thick boundary arises as the next scale
• Thin boundaries are ineffective, because they skip over one or more terms in the scaling hierarchy
• The concept of **THICK BOUNDARY** is important enough to use as a separate structural property
“Perforated, bent, and folded” (lecture 2)

• An “implied” center is defined only through a thick boundary
• Therefore, thick boundaries play a focusing role as well as a bounding role
• Complex semi-permeable urban boundaries must be thick!
4. Alternating repetition
Informational definition

• Essential translational symmetry
• But simplistic repetition is collapsible information
• What repeats is trivially coded (X, repeat 100 times)
• Contrast and repetition reinforce each other through alternation
5. Positive space
Refers to Gestalt psychology

- Ties into the basis of human perception
- Convexity plays a major role in defining an object or a space (area or volume)
- Mathematical plus psychological reasons
- Strongly applicable to the spaces we inhabit
- Threat felt from objects sticking out
Positive background

• Apply positive space concept to both figure and background
• Urban space must be positive; not only the building’s interior space
• Ignoring this property ruined most urban spaces built in the 20th century
6. Good shape
Good shape

- Symmetries reduce information overload
- Perceivable objects produce a represented shape from 2-D views, which the brain can computationally manipulate in 3-D
- “Good” means “easily graspable” — brain’s innate need to compactify information
- Shapes not easily represented strain the computation, hence induce anxiety
7. Local symmetries
Symmetries within hierarchy

- Within universal scaling, symmetries must act on every scale
- “Symmetry” does not mean overall symmetry, as is usually envisioned
- We have multiple subsymmetries acting within larger symmetries
- Hierarchically nested symmetries
8. Deep interlock and ambiguity
Interlock

• Another strong way of connecting
• Forms interpenetrate to link together
• Analogy comes from fractals, where lines tend to fill portions of space, and surfaces grow with accretions
• Abrupt transition does not bind
“Perforated, bent, and folded”

• Geometrical concept introduced earlier (in second lecture)
• Two regions interpenetrate at a semi-permeable interface
• Because interface enables transition, ambiguity as to which side of the interface one belongs
9. Contrast
Contrast is necessary:

• 1. To establish distinct subunits
• 2. To distinguish between adjoining units
• 3. To provide figure-ground symmetry of opposites
• False transparency reduces contrast
• Reduced contrast weakens design
Uses of contrast

- Space under an arcade versus open street space
- Strongly contrasted, yet connected
- Weak spaces: inside versus outside a glass curtain wall — no contrast
- Use contrast with interlock
10. Gradients
Gradients = transitions

• Getting away from uniformity
• Subdivision does that, but…
• — sometimes we should not quantize form into discrete pieces, but need to change it gradually
• Urban transect: city to countryside
• Interior spaces: public to private
11. Roughness
Many different manifestations of roughness — all positive!

• 1. Fractal structure goes all the way down in scales — nothing is smooth

• 2. Relaxation of strict geometry to allow imperfections — more tolerant

• 3. Ornament can be interpreted as “roughness” in a smooth geometry
Roughness and symmetry breaking

• So-called “imperfections” differentiate repeated units to make them similar but not identical — hand-painted tiles

• Symmetry breaking (approximate) prevents informational collapse

• Deliberate roughness in repetition
Roughness and adaptation

- Sustainability implies adaptation
- Local conditions create roughness — breaks regularity and perfect symmetry
- The whole changes according to its context thus it becomes unique
- *Hierarchy*: sustainability; adaptivity; uniqueness; roughness
12. Echoes
Two types of echoes:

1. Translational symmetry — similar forms found on the same scale but at a distance
2. Scaling symmetry — similar forms exist at different scales
3. All natural fractals obey fractal similarity — not exactly similar when magnified, but only “echoes”
13. The void
Largest scale of fractal

• Largest open component of a fractal survives as the void
• Not possible to fill in all of a fractal with detail
• In “implied” centers, a complex boundary focuses on the open middle — the void
14. Simplicity and inner calm
More subtle quality

• Lack of clutter — a separate property
• Balance achieved by overall coherence
• Symmetries all cooperating to support each other — nothing extraneous or distracting
• Appears effortless (though such coherence is in fact very difficult to achieve)
Simplicity in nature

• Never actually “simple” in the sense of being minimalist
• “Simple” in nature means extremely complex but highly coherent
• A system appears “simple” to us because it is so perfect; the form is seamless
15. Not-separateness
Achieving coherence

• Coherence is an emergent property — not present in the individual components

• In a larger coherent whole, no piece can be taken away

• Decomposition is neither obvious, nor possible
Measure of coherence

- When every component is cooperating to give a coherent whole, nothing looks separate, nothing draws attention
- This is the goal of adaptive design
- A seamless blending of an enormous number of complex components
- The opposite of willful separateness
Extending outside

• Not-separateness goes beyond internal coherence
• The whole connects to its environment
• Connects with everything beyond itself
• Try as much as possible to generate large-scale coherence
Breaking the 15 properties for fun

- 15 properties give coherent form, which is so natural that it is hardly noticed — like nature!
- Architects and students most often wish to draw attention to their designs
- Draw attention by violating properties
- But doing so causes physiological anxiety for user
Moral quandary

- Do I follow the 15 properties to design an adaptive, nourishing environment?
- Or do I deliberately break them and design an eye-catching project?
- Is playing with emotions (especially anxiety) likely to promote my work?
- What does the client demand?
Suppression of the 15 properties

• Whether consciously or unconsciously, architectural design in the 20th century has cultivated the \textit{absence} of the 15 properties

• Students and architects respond emotionally (very negatively) to them, from their image-based conditioning
Now architects have a choice

• The 15 properties question the validity of the contemporary built environment, and the ideology that gave rise to it
• Weak arguments support those forms
• Emotionally nourishing coherence, reflected in all traditional architectures, is both logical and inevitable
B. Three laws of architecture

- Can we find a reduced basis that includes most of the 15 properties?
- "A Theory of Architecture" argues by analogy with physical processes
- My own complementary approach — reinforces without in any way trying to substitute for the 15 properties
Law 1. *Order on the smallest scale*

- Established by paired contrasting elements
- Pairs create balanced visual tension
- Elementary particles with opposite characteristics couple — positive and negative charges, opposite spin states, opposite isospin states, etc.
- Pairwise binding on subatomic, atomic, and molecular levels, all on the short scale
Pairwise coupling
Crystallization
Law 2. *Order on the large scale*

- Elements relate to each other at a distance
- Configuration tries to reduce entropy (disorder) by shedding randomness
- Physical fields reduce energy by alignment
- Magnets align along field lines
- Crystallization reduces entropy
- Long-range forces imply ordering
Alignment — reorientation
Alignment along field
Law 3. *Links small to large scale*

- Linking occurs through a regular scaling hierarchy
- Universal scaling with factor $e = 2.7$
- Scales from the largest to the smallest are related by the same scaling ratio
- Already discussed in the first lecture
Scaling hierarchy in plan of urban space
Scaling hierarchy in building façade
Which of the 15 properties relate to the first law?

• “Alternating repetition” — repetition of contrasting pairs, not of single unit
• “Deep interlock and ambiguity” — local coupling occurs through geometrical interlock
• “Contrast” — the basis for coupling of units having opposite qualities
Which of the 15 properties relate to the second law?

- “Local symmetries” — disorder is reduced by local symmetries
- “Echoes” — similarity at a distance reduces entropy
- “Not-separateness” — field effect ties components together on different scales
Which of the 15 properties relate to the third law?

• “Levels of scale” — consequence of scaling hierarchy
• “Thick boundaries” — boundary is next-smallest scale in hierarchy
• “The void” — largest scale in hierarchy exists to balance all the smaller scales
Conclusion

• Alexander’s 15 fundamental properties are an incredibly essential set of practical design tools
• Arguments based on mathematics, physics, chemistry, and biology
• Architects have to accept them as universal, deciding on stylistic reasons whether to follow them or not
Conclusion (cont.)

• Traditional practitioners intuitively recognize some of the 15 properties as part of their own design method
• Yet, some are unknown to them
• Now put together into a coherent set
• I find it more useful to introduce them after having derived basic design rules