Hybrid Form

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Errata

A portion of this article was accidentally repeated and therefore incoherent when it was published in *Design Issues* Volume 19 Number 1. The corrected article is published here in its entirety.

Morphing is a term used to describe a process in which an object changes its form gradually in order to obtain another form markedly different in appearance, character, condition, or function.[1] *Familiar to most people as a cinematic device, in the movies morphing involves screen-based apparent rather than actual or substantive changes on the form itself. However, the significance of morphing for contemporary design discourse is not confined to cinematic special effects. Morphing is a powerful formal device that embodies one of architecture's most existential struggles: to express and identify itself through its own form. A distinctive characteristic of architecture is that it is both dynamic and static. It is dynamic when viewed as the design process which has its roots in historical precedents of culture and the arts, and which manipulates entities, that typically are of an elastic character. It becomes static when it has to freeze at a certain state so that it may be built. In other words, architecture is static when viewed through individual buildings. It is dynamic when these buildings are viewed as instances of a continuum, which derives from the past and projects into the future. In its dynamic stage, morphing involves transition, progress, continuity, interpolation, and evolution. In its static stage, it involves expression, connotation, mixing, combination, and bonding. Surprisingly, in architecture, morphing is not about change, but instead about a particular moment in time when the past and the future overlap within the same form. It involves transitional continuity and dynamic stasis. The identifiable characteristics of morphing are both unified multiplicity and intermediate distinctiveness. The architectural implementation of morphing suggests geometrical and topological transitions. Such processes involve operations that affect the geometry of a form, while preserving its topology. Morphing is the interconnection between seemingly disparate entities. In its dynamic stage, it is the struggle to connect the unconnected, dissimilar, unrelated, and unalike. In its static stage, morphing is the bond between the past and the present. It embodies a formal definition of reminiscence in its most primitive and primordial state.*

The process of morphing differs from the biological process of metamorphosis. While metamorphosis is the change in the form, and often function, of an animal during normal development after the embryonic stage, morphing is a man-made, artificial process of mapping between often unrelated entities. The transformation of a maggot into an adult fly, or a tadpole into a frog, follows natural biological laws. In contrast, morphing follows artificial rules. It is

1 An extensive introduction to morphing and warping for computer graphics is given by Jonas Gomez, ed. *Warping and Morphing of Graphical Objects* (San Francisco: Morgan Kaufmann Publishers, 1997).

the simulation of a mathematical interpolation. Thus, it appears to be a process of magic or sorcery, and the effects often may look strange, awkward, or surprising.

Recent theories of form in architecture have focused on topological geometry. They refer to "smooth spaces described by continuous yet differentiated systems resulting from curvilinear sensibilities that are capable of complex deformations in response to programmatic structural, economic, aesthetic, political, and contextual influences."[2] *A topological transformation, or a homeomorphism, of one figure into another is described as a bi-univocal and bi-continuous correspondence between the points of the respective figures maintaining the connection and vicinity of the points of the figure.*[3] *Topological operations involve folding, stretching, and compressing, but not tearing or cutting. Topology may be regarded as the unifying force that preserves the integrity of an indefinitely changing geometry.*

In this context, architectural morphing preserves the topological integrity of the objects involved, that is, an object changes into another object as a single entity. A cube, for instance, may be gradually transformed into a pyramid. From the viewer's point of view, there are always two objects: the "original" (or source), to which the transformation is applied, and the "destination object" (or target), which is the object one will get at the final step of the transformation. However, theoretically, there is only one object, which is transformed from one state (original) into another (destination). This object combines characteristics of both parent objects, which are involved in the transformation and is called the "hybrid object." This object actually is composed of the topology of the one object and the geometry of the other. It is an object in disguise. Although it is topologically identical to the one parent, it resembles the geometry of the other parent.

Interpolation is a method for estimating values that lie between two known values. The hybrid object derives its structure from its parents through formal interpolations. While it is easy to derive hybrid children from isomorphic parents, a challenge arises for heteromorphic parents. In an isomorphic transformation, a one-to-one correspondence applies between the elements of the two parent sets such that the result of an operation on elements of one set corresponds to the result of the analogous operation on their images in the other set. In the case of heteromorphism, the lack of homogeneity among the parents necessarily leads to a selective process of omissions and inclusions of elements between the two sets. The guiding principle in this mapping process is the preservation of the topological and geometrical properties of the hybrid object. For instance, in the case of a square mapped to a triangle, the addition of a fourth point to the triangle preserves the topology of the square and yet, its disguised location, preserves the geometrical appearance of the triangle.

2 This is Greg Lynn's interpretation of Gilles Deleuze's *The Fold: Leibniz and the Baroque* and Rene Thom's catastrophe diagrams. See Gregg Lynn, "Architectural Curvilinearity" in G. Di Cristina, ed., *Architecture and Science,* (Chichester: Wiley Academy, 2001), 27.

3 See G. Di Cristina, "The Topological Tendency in Architecture" in G. Di Cristina, ed., *Architecture and Science*, 7.

Figure 1
In the case of a square mapped to a triangle, the addition of a fourth point to the triangle preserves the topology of the square and yet, its disguised location, preserves the geometrical appearance of the triangle.

What makes morphing problematic for architects is that they have maintained an ethos of accumulative progression during the design process. Because of the artificial nature of design, architects traditionally follow an additive build-up approach. By contrast, morphing is a process of homogeneous transition. No elements are added or subtracted from the scene. Hybrid design is an alternative to the incremental design approach, which starts with components and builds towards increasing complexity as, for instance, building blocks. Instead, it starts with complex models or constructs, which get compared and transformed from one into the other. This allows an architect to impose a new condition or configuration on an existing design, create an evolution from one design to another, or explore the implications of contrasting design positions.

Traditionally, in architecture, skeletal shapes are used as abstract organizational schemes for the analysis or synthesis of buildings. These gestalt shapes are commonly known as "partis." They are symbolic configurations or patterns of elements so unified as a whole that their properties cannot be derived from a simple summation of their parts. The formal value of these shapes is tremendous since they not only describe the organizational structure of the building but also express in diagrammatic terms certain archetypal ideas and values associated with the theme of the building.[4] *In partis, enclosure, balance, direction, rhythm, hierarchy, and symmetry are depicted through the use of Euclidean shapes and geometrical configurations. A parti is not only a descriptive underlay, but also a symbolic manifestation. As the hybrid form strives to express itself through its parents' identity, a challenge arises in the selection of the parents. If partis are used as parents, then hybridization will occur between these archetypal shapes. The process of interpolation becomes the connecting bridge between interpretations. For instance, morphing a foursquare parti into a circle is not about four shapes that merge into one, but rather about the concept of hard, sharp, and equilateral changing into the soft, smooth, and concentric. The more the contrast between the parents, the higher the chances are for the hybrid form to juxtapose, cross-pollinate, and emerge.*

One of the main differences of morphing, as it compares to deformation, is in the duality of its identity. Deformation is understood as change relative to an initial state. As a point of reference, an archetype is needed to assess the degree of deformation. However, as the deformation persists, form reaches a threshold beyond which it becomes "unrecognizable," meaning that it is impossible to asso-

4 Handbooks such as Francis D.K. Ching's *Architecture: Form, Space and Order* (New York: Van Nostrand Reinhold Publishing, 1979) and R. Clarke and M. Pause, *Precedents in Architecture* (New York: Van Nostrand Reinhold, 1985) are also useful sources for establishing a foundation of architectural abstraction, a foundation, like all foundations, to build upon, and to exceed. Also see Rudolph Arnheim, *The Dynamics of Architectural Form* (Berkeley: University of California Press, 1977).

ciate it with its pivotal archetype. That is not the case in morphing. In fact, as the interpolation persists, the hybrid form oscillates between the identifiable shapes of its parents, allowing comparisons to be made at any point. This formal atavistic property is very important, because it becomes a means of expressing change through form itself, and not through juxtaposition. The duality of its identity is a unique compositional and unifying theme of the hybrid form.

In the interpolation process, a mapping applies between the elements of the two parent sets such that, the elements of the one set correspond to their images in the other set. Practically, multiple mappings can be constructed between the elements of the two sets. For every element in one set, any element of the image set can be mapped. While certain mappings appear to be more "natural" than others, every mapping is a valid transformation between the two parent sets. A "mutation" is an unexpected alteration to the hybrid's structure resulting in the creation of a new character or trait not found in the parental type. Mutation is an alteration that occurs during the creation process, and certainly not after. Since the creation of hybrid forms involves parents and mappings, a mutation may be defined as an "abnormal" mapping. The value of mutation is important since it represents a deviation from the ordinary, the common, and the predicted. It is about the exploration of alternatives, missing links, and new traits. A mutation has a high formal value, because it is associated with controversial interpretations. What appears to be a monster also may be worshipped as a god.

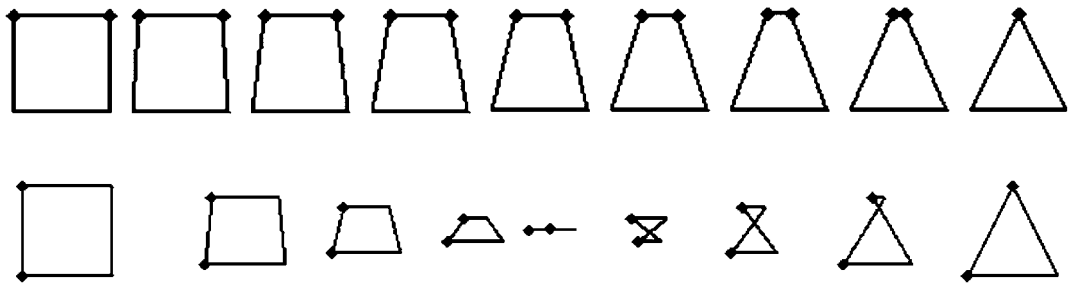

Figure 2
A "normal" (above) and an "abnormal" mapping (below).

The term "extrapolation" is used to describe the method of inferring or estimating by extending or projecting known information. By assuming that estimated values follow logically fro m known values, extrapolation estimates values outside a known range from values within a known range. Extrapolation is similar to interpolation. The method is the same, except the range of jurisdiction is antithetical. Because extrapolation is a logical extension of a known process, its formal value is not instantly understood. While interpolation is about middle ground, average, transition, and oscillation, extrapolation is about inversion, reversion, extension, and extremeness. Extrapolation represents a gateway to infinity. It is the starting point of inverted logic, in which the one parent is present

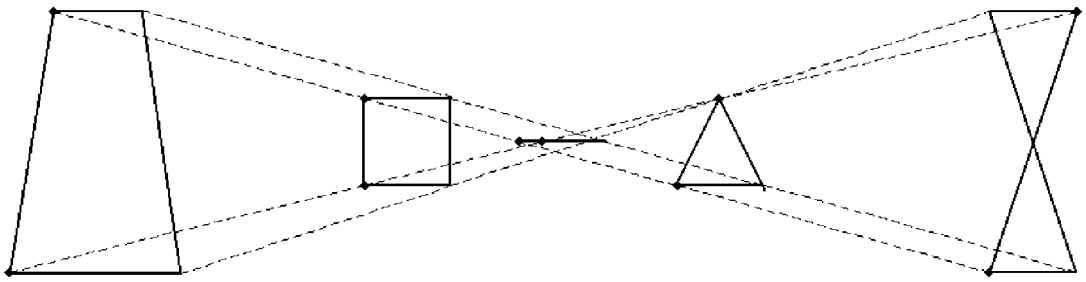

Figure 3
Extrapolation of a square through a triangle and vice versa. Notice that the child of two extrapolated parents is identical to that of the two Euclidean parents.

through its mirror image. The extrapolated form still is a hybrid. It may appear awkward, and yet it is perfectly consistent within the morphing scheme. In fact, the child of two extrapolated parents is identical to that of two normal parents.

If architecture is to approach morphing as an alternative de–sign method, its design technologies also should incorporate factors of time and change. The power of computation is in its ability to extend the human mind, and set the stage for experimentation into the unknown. The processes of interpolation and extrapolation are essentially mathematical processes and, as such, they can get codi-fied into quantitative methods. In contrast, manipulations, evalua-tions, and combinations of these processes are qualitative processes and, as such, can be handled by the architect.

As a design tool, the process of morphing can be imple-mented within existing computer-aided design systems. "Orches-tration" is a term used to describe the actions of selecting, assigning, directing, and evaluating the performance of objects which partici-pate in the morphing process. Transformations can happen concur-rently or at a different pace. The result is a truly dynamic design space, the behavior of which becomes the responsibility of the archi-tect. As in an orchestral performance, the architect/composer selects a number of objects to participate, assigns the proper paths and momentum for each one, and then directs the performance through time, form, and color.[5]

A challenging point is the fact that this new aesthetics is about the unknown, the unpredictable, and the unforeseeable. It requires the cooperation of two brains: that of the human and the computer because without one another it is impossible to plan or execute the hybrid objects. Most important of all, they lead to the creation of computational schemes, which are available for experi-mentation, analysis, or play across disciplines. The hybrid object contributes to our understanding of aesthetics, and creates a new dimension of how it may change our perception. It also brings up a social point: who is the creator? How will it change our perception if science and mathematics can be merged into the creative process?

5 One of the first attempts to use morphing in architecture was reported by Terzidis in 1989. Its intention was to introduce the hybrid object as an architectural parti. It is worth noting that the word "morphing" was invented later. See K. Terzidis, "Transformational Design," *ACADIA Proceedings* (1989).