The form of the house is not amorphous, not a free for all form. On the contrary, its construction has strict boundaries according to the scale of your living. Its shape and form are determined by inherent life processes.—Frederick Kiesler

Parametric design is not unfamiliar territory for architects. From ancient pyramids to contemporary institutions, buildings have been designed and constructed in relationship to a variety of changing forces, including climate, technology, use, character, setting, culture, and mood. The computer did not invent parametric design, nor did it redefine architecture or the profession; it did provide a valuable tool that has since enabled architects to design and construct innovative buildings with more exacting qualitative and quantitative conditions.

By the time of a conference held by the Boston Architectural Center in 1964, it had become clear that the electronic era would have a dramatic effect on building design. The aerospace industries were using computers to calculate complex warped surfaces and animated flight path simulations, which fascinated architects. [opposite page] As UCLA student Raphael Roig predicted in his unpublished master’s thesis, The Continuous World of Frederick J. Kiesler, “It would only be a matter of time before computer technology would be able to reduce to constructible terms the inherent intricacies of forms similar to Kiesler’s multiple-warped surfaces.” [opposite page] Kiesler and other artists and architects—including Antonio Gaudi, Erich Mendelsohn, Frei Otto, Kiesler, and Kiyonori Kikutake—had conceived and modeled complex structures and forms with varying degrees of technical proficiency, and Roig in the 1960s recognized that new computer technologies could assist their design and construction.

It was not, however, until the 1980s that breakthroughs in parametric design became useful to architects. Advances in the quasi-scientific field of plant and animal morphology supported innovation that could be applied with ingenuity to tectonic practices.
Nature had long since developed structural systems of nuanced complexity that architects and designers had applied to structure building shapes and urban organizational patterns. Louis Sullivan, Mies van der Rohe, Lozio Moholy-Nagy, Sir Patrick Geddes, and others, were influenced by the morphological writings of Goethe (Metamorphosis of Plants, 1790), E.S. Russell (Form and Function, 1916), and R.H. Francé (Plants as Inventors, 1920). Yet, despite important analytical advances made in D’Arcy Thompson’s On Growth and Form of 1917 (revised 1942), alongside subsequent mathematical models for shaping biological patterns developed by Alan Turing in 1952 and Aristid Lindenmayer in 1968, morphology had become a lost art toward the mid-twentieth-century. As with Kierler’s flowing forms, it had proven too difficult to measure and draw with detailed accuracy the evolving structures and intricate patterns of organic life. But between Rossini Mandelbrot’s 1982 study in The Fractal Geometry of Nature and K.J. Finkensteine’s 1990 developments in fractal theory, the computer emerged as a tool for simulating the generation of biological forms (morphogenesis). Coral, sponges, and other simple marine and plant life developing and responding to a limited set of measurable criteria—light, ocean current, nutrition, etc.—could be analyzed and reconstructed using parametric design models in the computer. Applying similar morphological simulations in architecture, designers in the late 1990s to mid-2000s began to use the computer alongside software developed for aerospace and the moving picture industry to “animate forms.”

Los Angeles architect Greg Lynn became the foremost theorist and designer to use the computer to generate what became his notorious “blur” and “fizz” architecture. His book Algorithmic Form (1999) studied the history and set the guidelines for architecture that could calculate growth using genetic systems and evolve it virtually in the computer. The “spline” proved most relevant for its simple and concise parametric capacity. It could be pushed, pulled, stretched, and manipulated in coordination with a set of data to produce a continuous curve that summed up the average of multiple vector information. (Images 1, “spline geometry” from Animal Forms, 1998, and 2, installation, 3D animation diagram, in Fields, Bodies, and Bonds, 1999)

Ben van Berkel and Caroline Bos Studio published the 1995 “Rubber Mat Project for Rotterdam, 2045,” which outlined how to use developments in fractal theory, the computer emerged as a tool for simulating the generation of biological forms (morphogenesis). Coral, sponges, and other simple marine and plant life developing and responding to a limited set of measurable criteria—light, ocean current, nutrition, etc.—could be analyzed and reconstructed using parametric design models in the computer. Applying similar morphological simulations in architecture, designers in the late 1990s to mid-2000s began to use the computer alongside software developed for aerospace and the moving picture industry to “animate forms.”

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These techniques could be implemented. Delivering the new Caltrans District 7 Headquarters (2004) to downtown LA in record speed, Thom Mayne and his team at Morphosis also proved it was possible for architects to design innovative, environmentally conditioned buildings that could be constructed more cost-effectively by working directly with manufacturers and fabricators. The computer proved useful not only for design, modeling, and fabrication, but for construction administration, as well. Morphosis’s Phare Tower may very likely prove to be the most advanced building to date to use parametric design technology and fabrication processes to achieve built form. [14, photo of physical model by Michael Powers]

Offshoots of these larger firms have made notable contributions to parametric design on a much smaller scale. Margaret Griffin and John Enright (formerly of Morphosis) working with Dr. Anders Carlson—a structural engineer educated at Caltech—exploited CNC milling processes to reveal and construct curvilinear plywood “I” joints to produce complex building structures. SPARCHS, working with Rogan Ferguson (formerly of Gehry and Partners), also alongside Carlson, investigated similar plywood CNC milled structures in addition to continuous tension shell technologies to build a series of roof planes parametrically to shifting environmental conditions using Computer Aided Three-dimensional Interactive Application (CATIA) software for their Seadrift House (2004) [15, 16]

Herwig Baumgartner and Scott Uria of B+U architects (both formerly of Gehry and Partners) developed innovative software for correlating varying parameters from moving crowds to urban sounds to inflect the patterns and shapes of their building designs [17].

The speed at which the architecture profession has been developing within the field of parametric design has been phenomenal. Much of this success can be attributed to the synergy occurring over the past fifteen years between the schools—UCLA, SCI-Arc, UC Berkeley, Cal Poly, USC, and CCA, among others—educating students with the skills needed for experimental practice, and the vanguard firms.

Not everyone, however, is enamored by computer design or the promises of parametric systems. At the same conference at the BAC in 1965, Christopher Alexander, then an assistant professor at UC Berkeley, warned that architects might “fatally distort the nature of design by restating design problems solely for the purpose of using the computer.” He did not believe that there were design problems—environmental or architectural—so complex that they required a computer to solve, and he was not convinced that architects would not oversimplify design complexity to meet the limited input and operational capacities of their computers. The computer could not keep pace with the facility of human intuition for inventing architectural forms and deriving design solutions for complex problems.

Mathematical parametric and algorithmic procedures most often have proven far too rigid to productively engage the complex cultural, societal, economic, and political projects facing architects today. Designing buildings and cities using parametric and scripting design tools may often appear visually stunning, but for the most part these designs tend to incorporate far too many blind assumptions to be able to respond with nuance to real world situations.

Today, many leading designers who engaged in parametric design over the past ten to fifteen years would to some extent agree. Moving away from the delimiting input techniques used to derive building forms and urban topologies, the design vanguard has began focusing more on the performative and affective qualities of architectue design and its practice.