Introduction

Andrew Kudless

Matsys / California College of the Arts

Neri Oxman

MATERIALECOLOGY / Massachusetts Institute of Technology

Marc Swackhamer

HouMinn Practice / University of Minnesota

It is curious that in order to define a discipline one must describe its boundaries. This delineation is especially problematic in the field of *design computation* as it encounters an expanding constellation of related domains. It has become rhizomatic, spreading horizontally across the various disciplinary landscapes, creating a multiplicity of creative nodes.

By reimagining boundary as a *frontier* rather than as a *constraint*, the field of design computation is thriving on unfamiliar volumes of trans-disciplinary knowledge. We, as experimentalists in this shifting domain, flourish on this new definition of boundary and the opening of new research territories it affords. However, we are increasingly discovering that as our point of view expands and we are able to access new tools and concepts from other fields, cooperation across networks is essential. From the academy to practice, design and research teams must become leaner yet broader reaching, allowing for the nimble flow of information between specialists. The dissolution of disciplinarity is a new condition of digital design production.

As a leading proponent of design computation, ACADIA has always occupied a gap between several traditional disciplines and has attempted through its annual conferences to map a connective landscape. Each year this map shifts geometrically and topologically, requiring conference organizers to zoom and pan in order to clearly illuminate change. In 2008, the map has again expanded, this time to connect design computation with biological processes and the emerging field of biomimetic design.

ACADIA 08, *Silicon + Skin: Biological Processes and Computation*, assembles researchers, scholars and practitioners to formulate an interdisciplinary discourse by fostering design work and research that lies at the intersection between design, biology, and computation. More specifically, the conference identifies and examines current trends in digital design technologies developed and applied in the framework of biologically inspired processes and digitally assisted sustainable design.

Although the domains of design, computation, and biology have their own rich histories that are well mapped individually, their synthesis and *its* history form the backdrop for this conference. This story features a series of individuals who were interested not in form, but formation. As Sanford Kwinter, one of the conference keynote speakers, states, "true formalism refers to any method that diagrams the proliferation of fundamental resonances and demonstrates how these accumulate into figures of order and shape"1. Kwinter goes on to describe the importance of the 19th century German writer and scientist Goethe in promoting the concept of generative form. Goethe's drawings of leaf morphology would be described today as parametric studies. One hundred years later, the Scottish polymath D'Arcy Thompson set out in his book *On Growth and Form* to establish a link between form and material behavior. He states, "The form, then, of any portion of matter, whether it be living or dead, and the changes of for which are apparent in its movements and in its growth, may in all case alike be described as due to the action of force. In short, the form of an object is a 'diagram of forces'"[2]. Thompson inserted the importance of matter and its behavior back into the discourse of morphology. Fifty years later, Alan Turing, father of modern computation, turned his attention to plant morphology for it was a natural topic for someone versed in the generative logics of pattern formation. Likewise, John Holland used his knowledge of computer science and evolutionary processes to investigate the synthesis of computational and genetic operations in his development of genetic algorithms and the search of artificial intelligence. Simultaneously, the German architect and engineer Frei Otto began exploring the architectural implications of working with the self-organization of material under force to form lightweight, large-span structures.

Since this time, a great number of individuals working in areas as diverse as robotics, philosophy, material engineering, computation, and architecture have attempted to distill the generative logics of natural systems into their work. This conference has gathered some of the most productive and influential of these individuals as keynote speakers. Sanford Kwinter and Michael Weinstock, both of whom are teachers, writers, and influential design theorists, have provided the emerging generation of architects with the conceptual tools to work in a world where technology and nature are merging. George Jeronimidis, provides the conference with an expert view into nature's complex material organizations

and what we can learn from them as designers. Finally, the last three keynote speakers are all emerging architects who have investigated the dynamic relationship between nature, technology, and design. Francois Roche of the French practice R&Sie(n), has developed a rich body of work exploring an experimental architecture fusing the natural and artificial into new symbiotic relationship. Similarly, Philippe Rahm, also and architect from France, has investigated the ability of architectural form to produce natural micro-climates. Finally, The Spanish firm AMID / cero9 lead by Cristina Diaz Moreno & Efran Garcia Grinda have created a portfolio of projects that playfully and beautifully combine elements of natural systems with the fundamental organizations of their structures.

Much of the work of these individuals could be categorized as being related to *biomimicry*, or the study and application of biological principles as essential design principles. Interdisciplinary by definition, the field of biomimetics has promoted a new sensibility to design made apparent across multiple scales of the design process, its artifacts, and their performance within the ever-changing environment. Recent initiatives within practice and academia that research and develop computational approaches and applications for the generation and evaluation of such artifacts are slowly turning this sensibility into a prosperous and lively discourse.

In organizing the paper sessions of ACADIA 08, the following topics were created in order to define and promote such a shift. Each of the session moderators has introduced each session's chapter with more complete descriptions of the topic, however the following can serve as a short overview of the conference's central themes and they questions they pose.

1 Concepts of Nature and Technology

As the relationship between nature and technology become more blurred, design can facilitate a new understanding of the world. Natural processes can provide designers with new models and strategies for design.

2 Generative Design Strategies for Complex Geometry

The introduction of computational design in architecture and design has allowed for an explosion of formal design possibilities. In order to gain more fundamental control over the possibilities, architects have turned to generative design strategies based on the parametric definition of a design problem.

3 Differentiated Systems, Landscapes, and Cities

The study of complex systems has led architects and urban designers to rethink the way in which large-scale systems such as landscapes and urban environments can perform more ecologically. Concepts such as system feedback, interaction, and evolution are essential for an emergent system to grow and adapt over time.

4 Approaches to Environmental Performance and Analysis

As architecture has attempted to integrate environmental performance into the design process, new techniques and strategies are required to deal with the complexity of non-linear systems such as flow of thermal energy.

5 Complexity, Emergence and Self-Organization

From evolutionary theory to neural networks, designers have attempted to adopt the processes of emergence and self-organization as design strategies.

6 Materials and Craft Inspired by Nature

In nature, as has been said many times, shape is cheaper than material. The biological world places little emphasis on excessive form or expensive materials and designers have begun to integrate these ideas into their design process.

7 Evolutionary Computation

Since John Holland's first genetic algorithms, the use of computation to simulate the process of evolution has been used to develop new artifacts that are "designed" by the interaction of iterative application of design criteria.

8 Non-Standard Production Techniques

An explosion in new production techniques that allow a greater range of form and behavior has paralleled the explosion of new geometric possibilities. These new techniques are often adopted from industries outside of architecture leading to a new relationship between the architect and the fabricator.

9 Spatial Mapping and Interaction

As our technology becomes more ubiquitous, new forms of interaction occur between humans and machines. The mapping and visualization of data is essential when silicon and skin are increasingly fusing.

10 Computational Methods for Data Integration

One of the hardest tasks in the design world has been how to deal with the complexity of design parameters. New strategies and tactics allow for a fluid interaction between design intent, performance feedback, and new ways of modeling and fabricating a design.

In addition to the papers presented in this volume, the ACADIA 08 conference also supports two exhibitions. The first exhibition, Anxious Climate, curated by David Gissen, collects the work of three of the keynote speakers firms: R&Sie(n), Philippe Rahm Architects, and AMID/cero9. The second exhibition, curated by Billie Faircloth and Kiel Moe, consists of peer-reviewed design work submitted by designers from around the world responding to the conference theme of design's relationship with biological processes and computation. The work of both of these exhibitions is published in a second volume.

This book represents a wide range of reflections and research to support computational methods in the design process. Combined, the application and development of computational protocols are proving themselves productive and meaningful in the fields of sustainable design, analysis, simulation and fabrication. Above all, the papers published here and presented at the ACADIA 08 conference describe one of the most accurate maps of the strategies and tactics being used across the design computation field at this time. Like all maps, it will become worn and then outdated, as the authors published here, as well as many others, will expand these territories and discover new ones. However, we hope that this map will facilitate the next steps in this evolutionary process.

Endnotes

1. Kwinter, Sanford. "Who's Afraid of Formalism?" in Phylogenesis: FOA's Ark. Barcelona: Actar, 2004.
2. Thompson, D'Arcy. On Growth and Form: The Complete Revised Edition. Dover Publications, 1992.